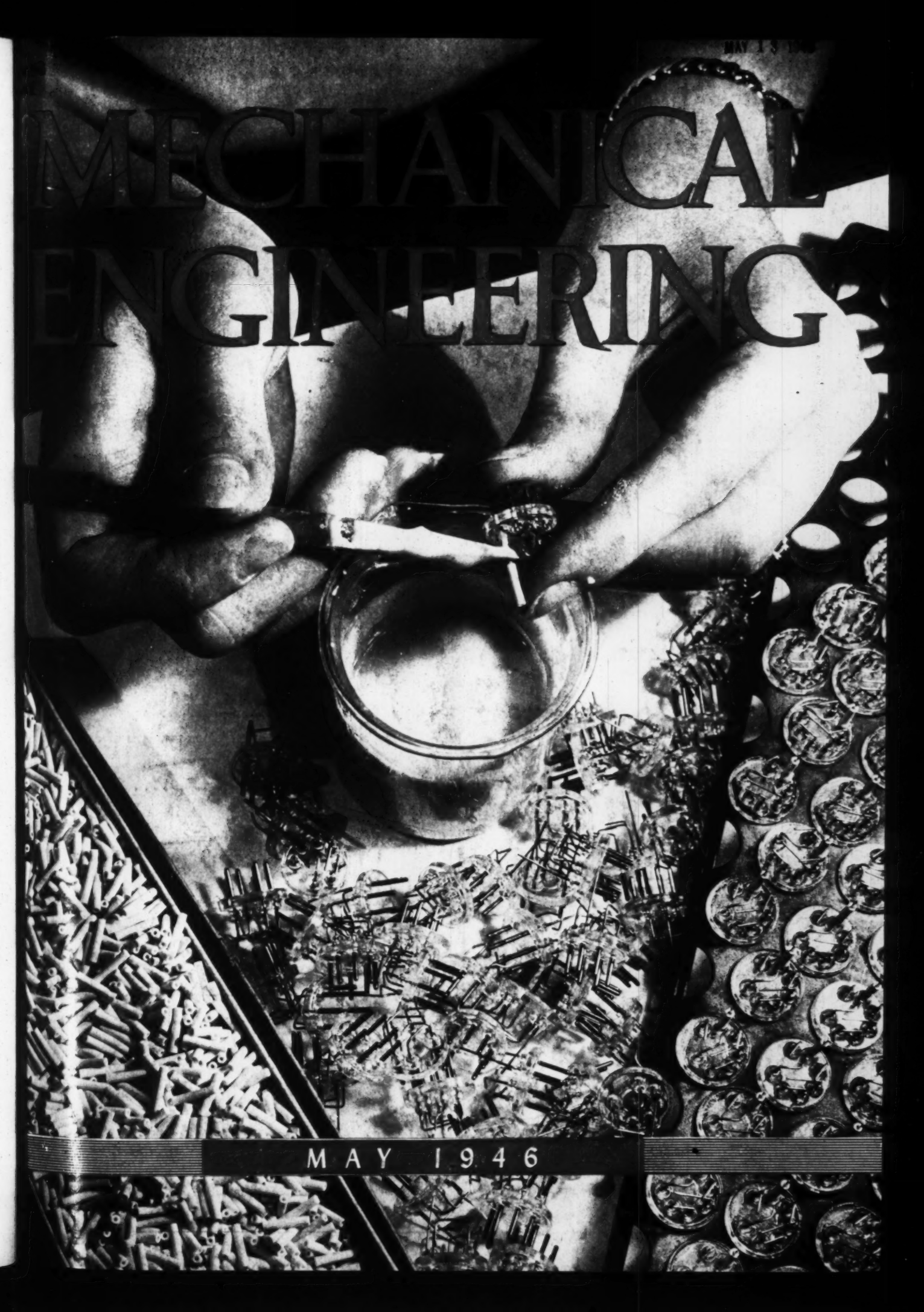
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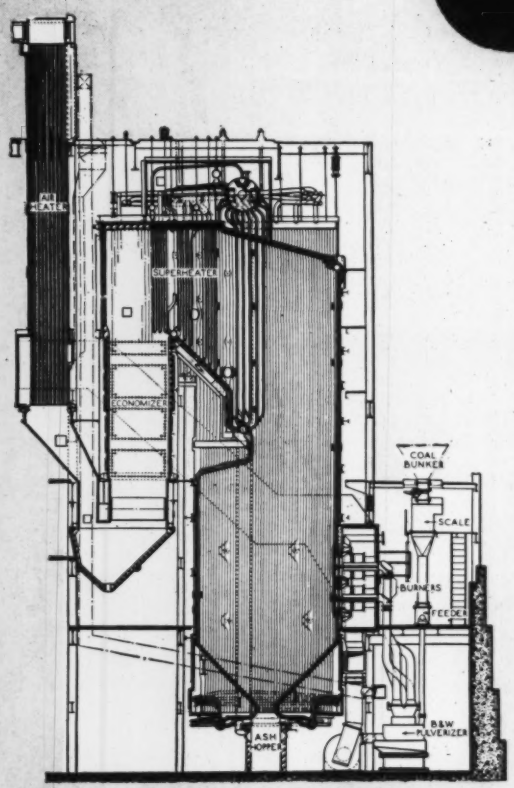
AFTER 18,000 HOURS INITIAL RUN...

...B&W BOILER TESTS "O.K."



B&W Radiant Boiler installed in Arkwright Station of Georgia Power Company in 1943. Maximum Continuous Steam Capacity—400,000 lb. per hr. at 950 psi and 860F.

FIRST rest in two straight years—over 80 per cent of the time on pulverized coal! More than 18,000 hours before, this B&W 400,000 lb. per hr. Radiant boiler, equipped with gas and coal burners, had started its record run in the Arkwright station of the Georgia Power Company.

When cooled down for its first inspection, the unit still held the original water, put in weeks before Tarawa and Cassino. Not a single manhole or handhole opening had been uncovered, for any reason, in all that time.

This initial inspection—first in two years revealed:

Boiler in excellent condition: no signs of distress or trouble of any kind.

Superheater: Condition excellent . . .

Economizer: OK . . .

Three B&W Pulverizers: In good shape . . .

Georgia Power Company: More than pleased.

While not trying to set a record, the southern utility, in its 18,000 hr. boiler run, demonstrates once again the dependability and continuity of operation built into every B&W boiler.

Water-Tube Boilers, for Stationary Power Plants, for Marine Service . . . Water-Cooled Furnaces . . . Superheaters . . . Economizers . . . Air Heaters . . . Pulverized-Coal Equipment . . . Chain-Grate Stokers . . . Oil, Gas and Multifuel Burners . . . Seamless and Welded Tubes and Pipe . . . Refractories . . . Process Equipment.

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Gearing for the Peacetime Fleet

(Stoning a burr on the first reduction gear for the propulsion unit of a C-3 cargo vessel at the South Philadelphia Works of the Westinghouse Electric Corporation. Fabricated of forged carbon steel rims connected to the hub by one-piece plate centers, the gears are hobbed in air-conditioned rooms to minimize expansion and contraction caused by minor temperature changes. In addition, large capacity batteries guard against interruption of the cut by a failure in the power supply. The C-3 cargo vessel is driven by an 8500 shp geared turbine.)

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No. 5

MECHANICAL ENGINEERING

MAY
1946

GEORGE A. STETSON, *Editor*

The McMahon Bill

THE Senate Special Committee on Atomic Energy, of which Senator Brien McMahon of Connecticut is the chairman, has unanimously agreed on the provisions of the McMahon Bill, S1717, as amended, for the control and development of atomic energy. On April 12, almost coincidentally with the announcement of this agreement, the presidents of four major engineering societies, the American Society of Civil Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Institute of Chemical Engineers, as individuals, addressed a joint telegram of approval and support of the Bill, as amended, to Senator McMahon. The text of this telegram will be found on page 480 of this issue.

In commenting on the telegram, W. E. Wickenden, president A.I.E.E., one of the signers, emphasized two points. The industrial use of nuclear energy, he said, would be highly competitive. At present the average cost of the energy source is about one sixth of the cost of electrical energy as commercially provided. The larger part represents the cost of services and facilities which fall definitely in the engineering realm. Present indications point to correspondingly high costs in the utilization of nuclear energy.

Nuclear energy as now released, he added, is essentially high-intensity heat which needs conversion into other forms to be used in industry and domestic life. Conversion, transmission, and distribution of energy are essentially engineering problems, including the safety features involved.

Three Generations

ON April 1, 1946, Loughnan St. Lawrence Pendred retired as editor of the British publication *The Engineer*, a post which he assumed in 1905. Pendred has served *The Engineer* for fifty years and has been editor since 1905. In this position he succeeded his father, Vaughan Pendred, so that for eighty years the dditorship has been held by father and son. And even now this family tradition is not to be broken for Longhnan Pendred's son Benjamin takes up the task. It may well be that the three generations of Pendred will cover one hundred years of service to this great engineering journal which has been one means of contact with engineering developments overseas enjoyed by thousands of engineers in this country.

Loughnan Pendred is well known to many A.S.M.E. members. Few there are who did not seize the opportunity to visit the editorial offices of *The Engineer* in Essex Street, if they were in London, to exchange views on developments on both sides of the Atlantic. Their reward was always a stimulating experience—a conversation enriched with a wisdom matured by time, salted with ready wit and pithy expression. Well remembered are the too-infrequent visits of Pendred to this country, and particularly the A.S.M.E. Fiftieth Anniversary in 1930 at which Pendred represented The Institution of Mechanical Engineers. Pendred's address in Washington on this occasion was a high point of a satisfying program of speeches. Seldom if ever had A.S.M.E. members heard King James' English more beautifully spoken.

Pendred prepared himself for his long service as an editor through a technical education, an engineering apprenticeship in England, and engineering pratice on the Continent and in his native land. At the age of 26 he joined his father as a subeditor and at 35 he was chosen to take his father's place in the editorship. During these years of service his accomplishments earned for him the presidency of The Institution of Mechanical Engineers of which today he is an honorary member. Many other honors have been bestowed upon him by his fellow countrymen.

Throughout the war years, in spite of dangers, and hardships, and his age, Pendred continued at his office to maintain the regular publication of *The Engineer*. It is gratifying to know that he still is able to enjoy his hobbies in whatever hours of leisure may now be his due and that he will continue occasionally to address the engineers of the world through the journal he served long and faithfully.

In Benjamin Pendred, the third generation takes hold. He falls heir to a rich heritage of service and responsibility. The engineering fraternity of the world wishes him well.

Humanistic-Social Studies

FOR a number of years engineers, and particularly teachers of engineering, have given much thought and study to broadening or liberalizing the engineering curriculum. In a report of the Society for the Promotion of Engineering Education issued in 1940 two major divisions of the curriculum were recognized, the scientific-technological and the humanistic-social. In 1944 a second report set forth the objectives of the human is

tic-social branch of studies. It is through this branch of studies that the engineering schools hope to achieve the broadening or liberalization of the curriculum that has been advocated by many individuals and groups. How the engineering schools have attempted to achieve the objectives of the humanistic-social branch of studies and general conclusions based on the methods used and results obtained are set forth in a report in the January, 1946, issue of *The Journal of Engineering Education*.

The report in question, "The Characteristics of the Humanistic-Social Studies in Engineering Education," was based on visits to eight institutions "which either exemplify various types of organization of humanistic-social studies or possess distinctive characteristics." It was prepared by Robert M. Boarts and John C. Hodges, of the University of Tennessee, who were commissioned to make the visits.

Plans for handling the humanistic-social portion of the curriculum in the eight schools visited fall into three general classifications, although the programs of the schools do not in general fall completely within any one of them. These plans, in the words of the authors of the report, are: (1) The articulated sequence of courses extending wholly through the four-year curriculum. (2) The lower- and upper-division plan, whereby the work of the first two years is distinguished rather sharply from the work of the two final years. (The arrangement of general studies in the first two years is sometimes called the pre-engineering plan.) (3) The plan of fixed required courses and rather free electives. (This plan is in wide use among engineering colleges at the present time, although many are scrutinizing their programs and restricting the freedom of election.)

In respect to the choice of these plans the authors conclude: "That system is the best for any school which best meets the purposes and objectives of the school with due consideration of (1) the size and type of its student body and (2) the special abilities and temper of its faculty."

It was found that forms of organization differed, but three generalizations are offered, as follows: "The support and some initiative must come from the faculty. The process of developing this support and initiative is slow. The executive officer should, in general, not attempt to hasten the process by fiat from above, but administrative leadership is essential to any successful plan."

In respect to the general objective of the program the authors state: "The formulation and acceptance of general objectives must be prerequisite to the development of a strong program in any school. Failure to do so can mean only that the faculty has not come to grips with the fundamental issues which confront each school individually."

A considerable portion of the report describes briefly the humanistic-social studies in the curriculum of each of the eight schools visited. Two generalizations are noted: (1) "In programs in which social consciousness is set forth as one of the objectives of the engineers' education, the study of history as a social science has been noted." (2) "There is no magic in any predetermined allotment of time for the humanistic-social activity. The objectives set by each school and the means available will dictate inexorably what is needed to achieve the program sought, thus a definition of a particular course as a member of a certain category is of small importance."

As to the relationship between technical and non-technical courses the authors state: "Those in charge of service and elementary courses have been dilatory in acquainting their colleagues in other divisions with the purposes, scope, and accomplishment of their several courses. The engineering staffs have been dilatory in not keeping better informed on the work of the service divisions, in not making full use of the skills already developed in the student, and in not promoting a better mutual effectiveness by conference or otherwise." They observe also that "to command the respect of engineering instructors, humanistic-social courses must demand of the students a minimum level of achievement comparable to that of the technical courses."

The authors of the report note that "increasingly the faculties of colleges and universities are insisting that courses intended for the liberal education of the student should be designed with that object in view. Too often an elementary course taken by all students is a beginning course for majors in that field. And too often these courses limit themselves to a specialized field of subject matter. As a result survey courses have been instituted—but these have their own shortcomings. Where broad courses were found in the schools visited, it was generally insisted that these courses were not of the survey type. The aim was entirely toward the teaching of principles, with a restriction of subject matter to accomplish that purpose."

"To find qualified teachers for these broad courses is difficult," the authors comment. "The graduate schools turn toward specialization. At the same time it becomes evident . . . . that the teaching of these broad fields is no job for amateurs. Attempts to use composite faculties, including engineers, for general courses are usually unsatisfactory."

Finally, the authors answer the question, "How can the liberalizing of technical education best be achieved?" by saying: "Technical education can best be liberalized by encouraging individual faculty members to achieve a broad and liberal viewpoint and to reflect that viewpoint in their teaching."

It is abundantly evident that the war has greatly magnified the consciousness of engineers and scientists of their responsibilities to society. It was more than foresight on the part of S.P.E.E. that their concern for the humanistic-social studies in the engineering curriculum was well advanced and deeply rooted before the war began and that steps had been initiated to liberalize engineering education. For this liberalization is perhaps the soundest method of awakening young engineers to the relationship between engineering and the contemporary civilization of which it is a part, and hence of instilling in them sense of responsibility.

The FUTURE *of* NUCLEAR POWER

By JOHN ARCHIBALD WHEELER

ASSOCIATE PROFESSOR OF PHYSICS, PRINCETON UNIVERSITY

THE atomic-energy plants of the Hanford Engineer Works are located near what was once the little agricultural town of Hanford, Washington (Fig. 1). The plants lie in a country of sagebrush and sand on the bank of the beautiful blue Columbia River, about halfway between the Grand Coulee Dam and the Bonneville Dam. The author can testify that one could not ask for a quieter, smoother-running, or more reliable plant, having followed its operation from its start-up on September 26, 1944, over the period of the past 16 months. It can now be stated that the possibility of the controlled release of atomic energy does not have to be proved—it is an accomplished fact.

HANFORD BUILT AS PLUTONIUM PLANT

The Hanford plant was not built to generate nuclear energy, however. Its purpose was to synthesize a new chemical substance, plutonium, element 94, to make atomic bombs. The production of heat in this reaction was not merely incidental; it was a positive drawback in the program to make as much plutonium as possible. For example, the production of as much as 1 kg of plutonium per day requires the release of an amount of heat between 500,000 kw and 1,500,000 kw. From these figures it will be understood that problems of heat transfer and heat dissipation controlled the capacity of the Hanford plants to synthesize plutonium. These problems are engineering problems.

In the nuclear-energy plant of the future the liberation of energy in the form of heat or otherwise will be the primary objective and the production of plutonium or other substances subject to nuclear fission will be secondary. But the most difficult problems will still be engineering problems: (1) To transfer heat from the chain-reacting structure, the so-called pile, to a cooling fluid and (2) to convert this heat into usable energy. The problems of nuclear physics which enter into the design of the power-producing pile of the future have in principle been solved. The concensus of opinion of the industrial men and the scientists who have been connected with the uranium project is that, assuming freedom to develop, it is only a question of time before we shall have an industrial technology of nuclear energy which can pay its own way. The time interval will depend most of all upon the engineering talent which is applied to the solution of the engineering problems of the pile.

CHAIN-REACTING STRUCTURE OR PILE OF THE FUTURE

Nuclear physics indicates that the power plant of the future will be in six important ways quite similar to the present Hanford piles of which Fig. 2 is typical.

Nuclear Fission. The heat-releasing reaction will be fission, the division of a heavy atomic nucleus into two parts of approximately equal mass. We can exclude from consideration other transformations such as the reactions of lighter atomic nuclei which provide the heat of stars. These reactions occur at a significant rate only at temperatures between 1,000,000 and 50,000,000 deg. That it will not be feasible to make industrial plants operating at such enormous temperatures is clear enough when one observes the destructive power of a body as hot as an atomic bomb. Nuclear fission, on the other hand, requires for its production, not high temperatures but only bombardment of the nucleus in question by the elementary particle or "neutron" Fig. 3.

Without inquiring more about the nature of this particle just now, we can note that not only is one neutron sufficient to produce fission, but also that the act of fission produces in turn several new neutrons. The release of these particles at the time of splitting will not come as a surprise to anyone who has observed carefully the mouth of a slowly dripping water faucet. As each big drop breaks away, several tiny droplets are formed and thrown out from the point of division. This rather minor side reaction in the process of breaking off a water droplet is all-important in the act of fission for it provides several neutrons, each of which can produce a further fission process, provided that more nuclei are available which are susceptible to nuclear fission.

Basic Material. The foregoing requirement brings us to the second feature of the present chain-reacting units which will be preserved in the piles of the future; we require as source of energy a substance which undergoes fission with high probability when struck by a neutron. There are only a few nuclear species which satisfy this condition. They are all comparable in atomic weight to uranium, or heavier than it. The two most prominent examples of such fissionable materials are plutonium-239, the most important variety of the new and 94th chemical element; and uranium-235, the variety of nucleus which is present to 1 part in 140 in ordinary uranium. Both nuclear species play an important part in the Hanford piles. The U-235 undergoes fission and thus maintains the nuclear chain reaction. Most of the extra neutrons not needed for continuance of the chain reaction are used in synthesizing the new fissionable element, plutonium. The pile of the future must operate by fission of one or the other of these two substances or of some nuclear species very near to these two in the periodic system of the elements.

Fissionable Material Must Be Replaced. Unfortunately, none of the desired fissionable species of nuclei exists in nature in anything but insignificant traces, except U-235. Furthermore, the task of separating U-235 from ordinary uranium is difficult and expensive. Consequently, it is reasonable to ask of the pile of the future a third feature, that it should synthesize by a suitable side reaction as much as possible of the fissionable material which is burned up during operation. Here again the Hanford piles point the way. At the same time that their operation burns up the one fissionable material, U-235, it creates the new and equally desirable fissionable species, Pu-239.

In partial explanation it may be said that the process of synthesis starts with the very abundant but otherwise useless nuclear species, U-238. This species, by capture of a neutron and a resultant sequence of changes, is transformed into the wanted Pu-239. One may ask, if the heat given off in this

Presented at a meeting of the Metropolitan Section, New York, N. Y., January 30, 1946, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

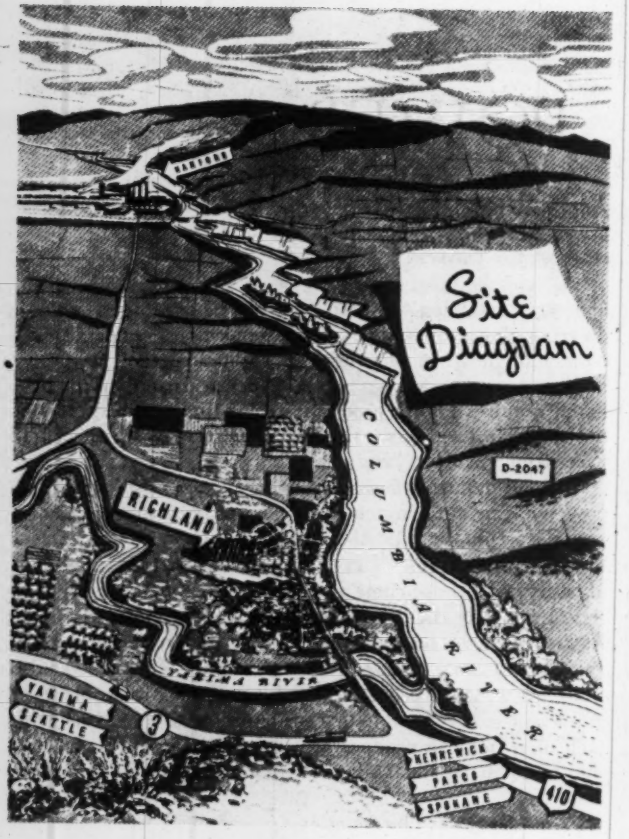

FIG. 1 VIEW OF PLUTONIUM PLANT AREA IN STATE OF WASHINGTON, SHOWING 30-MILE SEPARATION BETWEEN PILE AND SEPARATION AREAS AT HANFORD AND RESIDENTIAL VILLAGE AT RICHLAND
(From Smyth report, "Atomic Energy for Military Purposes.")

reaction was such a source of engineering difficulty in the war program, why bother to go to all the trouble to destroy one perfectly good bomb-making material in the course of making another one? The answer is simple. It was much easier to separate out from the original element, uranium, the new and chemically distinct element, plutonium, than it was to separate two forms of uranium from each other. The objective of the Hanford program was to avoid the problem of separation of two different species of the same chemical element and to replace it by the problem of chemical separation of two distinct elements.

It paid to do this in spite of the heat-transfer difficulties which were encountered and in spite of the fact that all the heat was thrown away. However, in the pile of the future, where the heat energy will be the primary point of interest, considerations of economy will give us the same incentive we had to produce fissionable material from an otherwise relatively useless raw material such as the abundant U-238.

In future attempts to accomplish this regeneration process there will be one or other of two possible outcomes. It may be that each day of operation of the pile of the future will burn up, let us say, 1 kg of the original fissionable material and regenerate out of U-238 or similar inert material possibly only 0.9 kg of new fissionable material such as plutonium. In this case the plant can continue operation only if we supply from outside each day 0.1 kg of new fissionable material. This requirement will prevent atomic energy from becoming quite as cheap as we should like to have it.

The other possible outcome is more favorable to economy of raw materials. In every day of operation in which we destroy 1 kg of fissionable material we synthesize from an inert substance more than 1 kg of new fissionable material, say, for example, 1.1 kg. In this case we leave 1 kg of the new product in the plant to make up for the losses of the day and remove the other 0.1 kg to help start up a new pile; or if necessary, to help make atomic bombs. In case we can achieve this outcome, there is no need for us to supply new fissionable material to our plant from the outside, except to get it started. After it is in operation we could even feed it as raw material uranium from which all of the active constituent, U-235, has been extracted, although it would be cheaper to use natural uranium. The plant itself will convert the inactive uranium to fissionable material for use in the chain reaction. Evidently we have only to design a plant with sufficiently good regeneration characteristics in order to use for power purposes all of the uranium, not merely the rare constituent U-235.

Continuous Supply of Raw Material. However good the regeneration characteristics of our future power plant, or in other words, however efficiently we use the raw material, we must obviously still have a continuous supply of raw material. This requirement brings us to the fourth point of similarity with the Hanford chain-reacting units. It will be necessary in the future as in the past to use for raw material either uranium itself or possibly, we may hope, some other element of comparable abundance in the earth, but with a neighboring or higher position in the periodic table of the elements. The only such substance which exists in nature is thorium, an element apparently somewhat more abundant than uranium. Consequently, the pile of the future will be expected to use as source of energy either uranium or possibly thorium.

Chemical-Separation Plant. There is a fifth requirement on the nuclear power plant of the future which is not so obvious as those which have gone before. Associated with the power unit there should be a chemical plant for the treatment both of the raw material and of the fissionable material after they have been exposed in the pile. We will expect different locations to be chosen for these two materials to get the best results. But as time goes on, fissionable material will be synthesized within the relatively inert raw material. If this fissionable substance is allowed to stay where it is, it will eventually be struck by a neutron and be caused to split, but to split at a point in the pile where the neutrons which it gives off will not be used with full effectiveness. To avoid this loss of efficiency, which might be serious, we must expect to have to withdraw the raw material periodically from the unit and extract from it the newly synthesized element. The two components that result from this chemical separation process will then be sent back to their proper places in the pile, the raw material to one location, the fissionable material to another.

This is not the only task which the chemical plant will have to perform. The fissionable material will also experience changes which will call for its reprocessing. The products of nuclear fission, elements of medium atomic weight like barium, lanthanum, xenon, rubidium, selenium, tellurium, silver, ruthenium, will accumulate and poison the chain reaction by absorbing the neutrons which we want for more productive purposes. Consequently, we will expect to have to remove these by-products of the reaction from time to time from the fissionable material, whether this material is U-235, Pu-239, or something else.

Of course the separation plant of the Hanford pile does only a part of what we demand of the separation plant of the future. It withdraws from the working material only the plutonium which was required for atomic bombs. It is designed to produce plutonium by the most straightforward possible means, with no attempt to serve as a power plant. Consequently, it

does not need to prepare the working material, uranium, for reintroduction into the unit.

Protection Against Radioactive Radiations. The final major point of resemblance between the future plant and the Hanford pile is the requirement of protection of human beings against radioactive radiations. Not only does the act of fission liberate fast and penetrating neutrons, but it also releases electromagnetic radiations which have the same character as x rays and even greater piercing power. These so-called gamma rays, together with the neutrons coming from a pile in full production, have near such a reactor an intensity more than a million times as great as can be tolerated biologically by the human organism. It is necessary to surround the pile with a shield which will cut down the intensity of these radiations to a negligible level. One can imagine the difficulties which arise in obtaining complete protection when it is considered that there must be openings in the shield for the entrance and discharge of the cooling fluid and for the insertion and the removal of uranium or other working material before and after irradiation. It is gratifying to be able to say that these structural problems not only can be solved, but that they have been solved at the Columbia River plants, and solved in a very satisfactory way.

SHIELDING A LIMITING FACTOR IN FUTURE APPLICATIONS

However, it is necessary to report that the required shielding weighs a great deal. Even for a unit generating as little as a 100 kw the shielding has a thickness of a number of feet and weighs in the order of magnitude of 50 tons. Unfortunately, there is no device at our disposal to overcome this difficulty. The principles of shielding are very simple and straightforward. What counts is essentially the product of the thickness and the density of the protective material. This circumstance means that even with the densest practical materials there is a minimum required thickness for the shield.

It might just be possible to carry such a shield through existing railway tunnels on a locomotive driven by nuclear power, but the prospects for train propulsion are not bright. Atomic power appears to be quite out of the picture for automobiles. The same conclusion applies also to airplanes, at least until the weight carrying capacity reaches ten to a hundred times the present figure. On the other hand, it is quite in order to count on nuclear energy for driving ships or for running a stationary electric power plant. In neither application does a heavy shield cause too much difficulty.

Fortunately, the required weight of the protective material

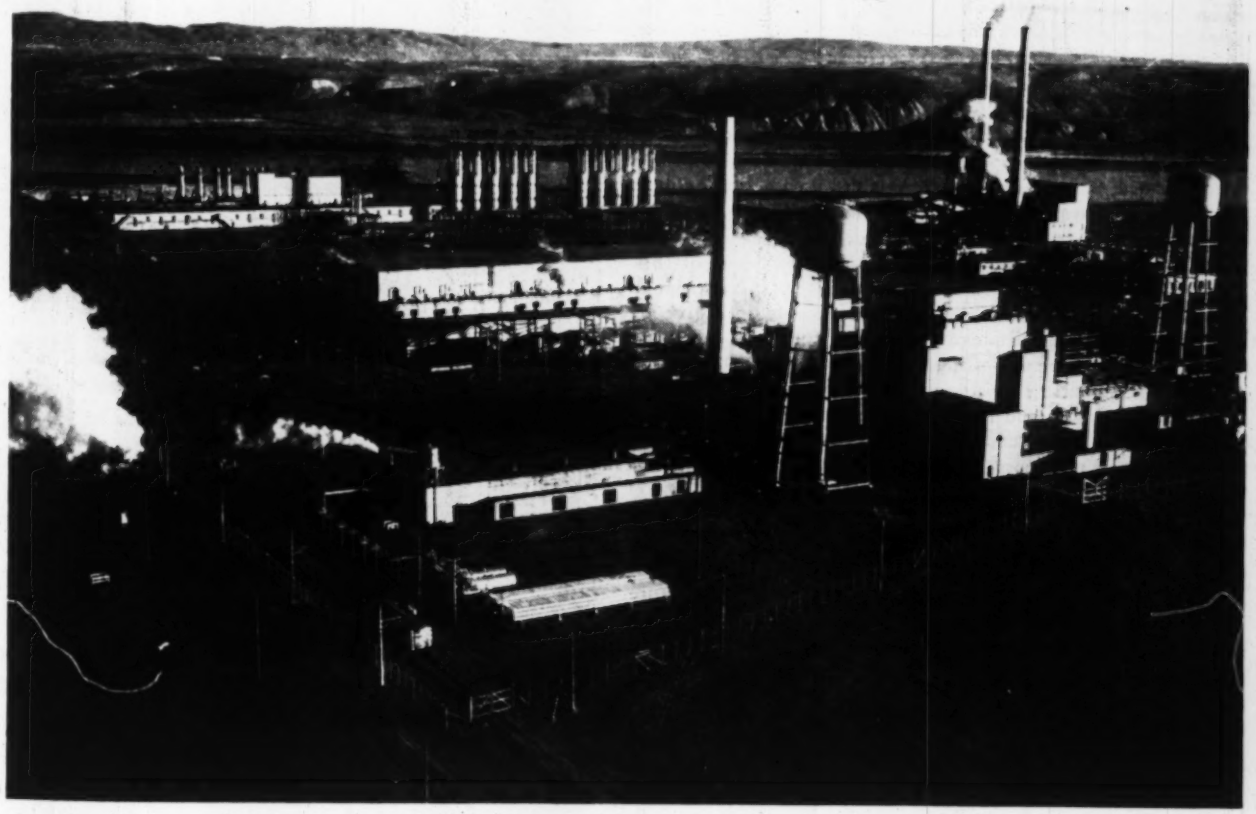

FIG. 2 ONE OF PILE AREAS AT HANFORD SITE

(The obvious powerhouse and pumping station illustrate the similarity between a nuclear and a standard power plant. The actual building in which the pile is located cannot be pointed out for security reasons. From Smyth report, "Atomic Energy for Military Purposes.")

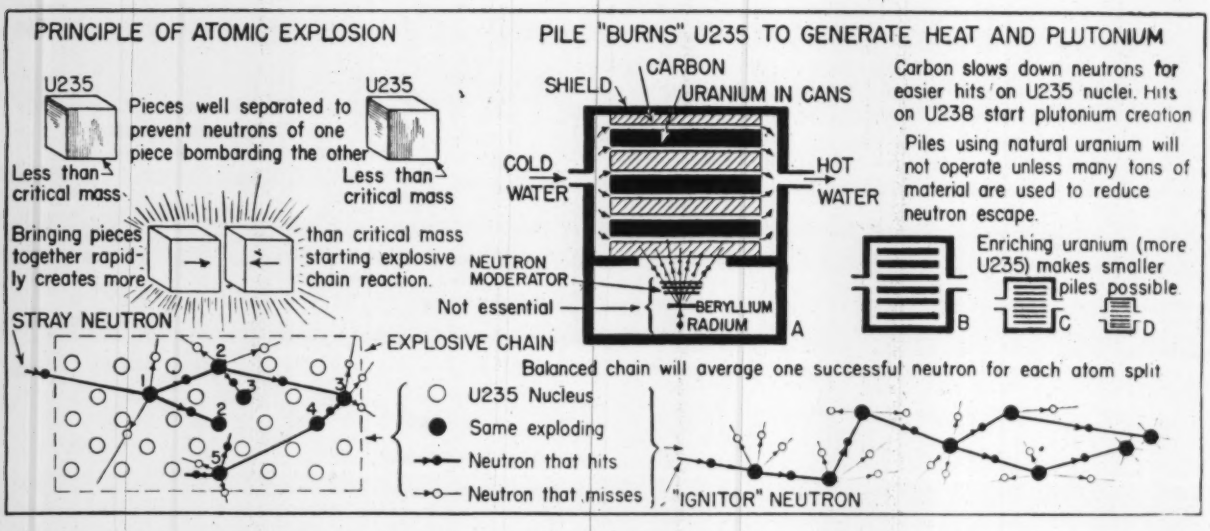
PRINCIPLE OF ATOMIC EXPLOSION
U235
U235
Pieces well separated to prevent neutrons of one piece bombarding the other
Less than critical mass
Less than critical mass
Bringing pieces together rapidly creates more than critical mass starting explosive chain reaction.
STRAY NEUTRON
EXPLOSIVE CHAIN
U235 Nucleus
Same exploding
Neutron that hits
Neutron that misses
PILE "BURNS" U235 TO GENERATE HEAT AND PLUTONIUM
SHIELD
CARBON
URANIUM IN CANS
COLD WATER
HOT WATER
NEUTRON MODERATOR
Not essential
BERYLLIUM
RADIUM
A
Carbon slows down neutrons for easier hits on U235 nuclei. Hits on U238 start plutonium creation
Piles using natural uranium will not operate unless many tons of material are used to reduce neutron escape.
Enriching uranium (more U235) makes smaller piles possible
B
C
D
Balanced chain will average one successful neutron for each atom split
"IGNITOR" NEUTRON

FIG. 3 SCHEMATIC DIAGRAM OF OPERATION OF A PILE WITH URANIUM SLUGS, SHIELDING, AND PROCESSING OF SLUGS

(Neutrons issue from slugs of uranium as a consequence of fission and pass out into surrounding graphite matrix. There they are slowed to energies at which, on re-entry into the uranium, they have a good opportunity to be captured into the fissionable isotope U-235 and induce further fission. By this arrangement the chain reaction is kept going. Most of the neutrons which are not utilized in this process are captured by the inactive uranium isotope, U-238, and cause it to transform into the fissionable material, Pu-239, plutonium, which is the goal of the Hanford process. From supplement to *American Scientist*, October, 1945, courtesy McGraw-Hill Publishing Company, Inc., New York, N. Y.)

does not increase greatly with power level. Consider a shield thick enough to reduce to a biologically acceptable intensity radiations from a pile which in the absence of shielding would be a million (10^6) times too intense. Increase the power output of this pile tenfold, so that the radiation is ten million (10^7) times the acceptable level. Then it is only necessary to increase the thickness of the shield in the ratio of 7 to 6 or 17 per cent to shield the 10 times more active pile.

Some emission of radiations continues even after the chain reaction is brought to a halt. Some of the products of nuclear fission, elements of medium atomic weight, are radioactive when formed. These active materials are present in the irradiated uranium which is discharged from the Columbia River piles, and therefore in the uranium which is received by the chemical separation plant at Hanford. What is true of this separation plant will be true of the chemical plant associated with all future piles; shielding is indispensable. To give an impression of the magnitude of the shielding problem, it may be mentioned that there was poured at Hanford 780,000 cu yd of concrete. Of course this amount of material was distributed over several plants, and only a part of it went for shielding purposes. The magnitude of even a single plant is necessarily so great that it may possibly not be economically feasible unless it is designed to produce at least as much as perhaps 100,000 kw of power.

COOLING FLUID FOR ATOMIC POWER PLANT

In the Hanford piles the cooling fluid is water; in the future power plant this fluid will be some substance capable of going to much higher temperatures than water without requiring very high pressures, Table 1. High pressures would require heavy piping; but every foreign material introduced into the pile absorbs neutrons and makes it that much more difficult to run the unit efficiently. In contrast to the pressure, the temperature of the pile is a matter of relative indifference from the point of view of the nuclear-chain reaction. It matters little to the fission fragments whether the temperature of the uranium is a few hundred degrees or more than a thousand degrees, for their own instantaneous energy at the moment of production is equivalent to more than a billion degrees. It will therefore be reasonable to operate at as high a temperature as our materials of construction will stand and gain all the thermodynamic efficiency that we can in our power plant. The cooling fluid, whatever it is, will then be led out to a heat exchanger. There its energy will be turned over to water or mercury or some other substance capable of driving a tur-

TABLE 1 NEUTRON ABSORPTION IN CONSTRUCTION MATERIALS[a]

Substance		Cross section per nucleus of most absorbent element	Adopted density	Neutron path for 10 per cent absorption
Water	(H)	0.25×10^{-24} cm²	1.00	6.3 cm
Heavy water		.....	1.11	....
Lithium	(Li)	58×10^{-24} cm²	0.53	0.039 cm
Beryllium	(Be)	$<0.03 \times 10^{-24}$ cm²	1.8	>29 cm
Beryllium oxide		.....	...	....
Boron	(B)	500×10^{-24} cm²	2.5	0.0015 cm
Graphite	(C)	$<0.06 \times 10^{-24}$ cm²	1.6	>22 cm
Fluorocarbons	(F)	0.05×10^{-24} cm²	1.8	>30 cm
Sodium		0.38×10^{-24} cm²	0.95	11.2 cm
Magnesium		0.31	1.74	7.9 cm
Aluminum		0.42×10^{-24} cm²	2.7	4.2 cm
Iron		1.6	7.8	0.78
Nickel		3.6	8.7	0.33
Copper		2.6	8.9	0.48
Silver		58	10.5	0.03
Cadmium		2950	8.6	0.0008
Mercury		325	13.6	0.0079
Lead		0.32	11.0	10
Bismuth		0.33	9.8	11
Uranium		(~6)	18.7	~0.37

[a] Based on data of H. Volz, *Zeitschrift für Physik*, vol. 121, 1943, p. 201. These data are taken from this German source because more recent American data are not available.

NOTE: The figures in the right-hand column give the average path length which a completely slowed, or "thermal," neutron can travel in typical materials before experiencing a 10 per cent chance of absorption. From this table it is evident that such a material as mercury is not suitable for transferring heat from hot uranium in a pile of Hanford design to a turbine or other power-generating device. The same table shows that sodium, lead, or bismuth are cooling materials which might be acceptable from a nuclear viewpoint. Boron and cadmium are seen to be materials effective in controlling the rate of a nuclear-chain reaction.

bine or other prime mover. That is the power plant of the future.

USE OF RADIOACTIVE MATERIALS

A great deal has been said about the use of radioactive substances without adequate realization of the hazards involved. It is feared that the country as a whole is not going to realize how great are the dangers of the uncontrolled use of such materials until a number of people shall have lost their lives, either through their own carelessness or through the negligence of others. The extraordinary health and safety record of the plutonium project has drawn attention away from the difficulties which were encountered, and which were solved to guarantee the safety of all the workers on that project. We cannot be sure in the future that the organizations which will deal with these materials will have the same appreciation of the importance of safety as the du Pont Company and the Monsanto Company, nor that they will have the same sound medical advice which was provided by the so-called Metallurgical Laboratory of the University of Chicago.

The problems of adequate control of the use of radioactive substances in the future appear too great to be handled on a merely voluntary basis. It may very well be necessary to have all chemists who deal with radioactive materials specially trained in regard to safety precautions, and licensed and bonded to the state or national government. Let us hope that some such system is set up while we still have the sound practice of the plutonium project as a working model, and before anyone has lost his life through lack of proper legislation.

The radiochemists of the future will have many radioactive materials at their disposal. Most of the chemical elements of medium atomic weight created by the act of fission are formed in a radioactive condition. Other elements can be made radioactive by exposure in a chain-reacting pile. For the active substances which will be obtained by these means there will be a number of specialized uses, such as the painting of watch dials, the examination of heavy castings by means of penetrating radiations, the treatment of the blood disease known as leukemia. But it is probable that our greatest benefits from these materials will be indirect, and will come from our having a powerful tool for the study of chemical and physiological changes. Tagged atoms will give us information which we can get by other means only with the greatest difficulty, or not at all. Among such tools one of the most important will be the tagged atom or radioactive nuclear species known as carbon-14.

The uses of radioactive substances, in spite of their importance, require relatively small amounts of material. We cannot expect that the radioactive business will be one with a large income. This business will be subordinated to power-plant activity, not the other way around. We have to count on the power plant to pay its own way as a power plant, except as it serves as the source of bomb-making materials.

MILITARY ASPECT OF ATOM IS PARAMOUNT

Just as the production of radioactive materials is a small matter compared to the release of nuclear power, so in turn this power must today and forever in the future be considered as a matter secondary to the military applications of the atom. It is certainly desirable for us to have in the future nuclear power plants as a source of electrical energy which is suitable for general use in special sections of this country and for special uses in the whole of the country. But it is essential to the future of the United States and the United Nations that it have this law-enforcing power ready at hand. It is for this reason most of all that we must see that this country develops a strong technology of nuclear energy.

A good deal has been said, and very rightly so, about the destructive power of the atomic bomb. The discussions, however, tend to give the false impression that it is only necessary to have a certain stock of these bombs on hand to stop future transgressors. This conclusion may be correct in some cases; but if there is anything which has been shown by the history of the last two wars, it is that one cannot count on a stockpile of anything to stop the aggressors who are really important. What is required is productive capacity and know how; and productive capacity means big atomic power plants.

Let us analyze what is meant by productive capacity and know how. What advantages did this country have in the atomic-bomb project during the war? (1) The scientists; but other countries had them also. (2) Imaginative and courageous support, to the everlasting credit of President Roosevelt and to our own good fortune. But imagination is no longer required in the future to see that this field requires support. (3) We had the industrial know how and productive capacity to do the job. We could have furnished Japan not only with all our so-called purely scientific information, most of which they had anyway, but even with the blueprints of the final installations, and still the Japanese would not have been able to make atomic bombs.

Where could they have made the special aluminum parts that were required, parts that required for their manufacture the most advanced facilities possessed by the aluminum industry in any nation in the world? How would they have got the facilities to convert uranium compounds into uranium metal, a problem that was solved only through the experienced advice and help of industrial concerns working closely with our best metallurgical laboratories? Where would they have got the enormous quantity of graphite, let alone the purity of graphite required to construct the chain-reacting piles of the Columbia River project?

The facilities to make these things cannot be built up over night. They are the creation of thousands of intelligent and skillful men working over a period of years. It would have done us no good if we had had locked up in the safes in Washington the blueprints for graphite ovens, the drawings for aluminum-fabricating machinery, the procedures for smelting uranium. What counted was our industrial know how and our manufacturing facilities. With them the blueprints could, if necessary, be dispensed with. Without them the blueprints would do us no good.

SECURITY LIES IN INDUSTRIAL DEVELOPMENT OF NUCLEAR ENERGY

Our true security lies not in secrecy, but in a strong industrial development of nuclear energy.

This point is emphasized because some of the legislation now under consideration in Washington would make it practically impossible for any industrial concern to enter the field of nuclear power generation. The author is quite in sympathy with the conclusion that the Government must have control over all fissionable materials. That is an obvious condition for all security. But there is danger that many are now overlooking an equally obvious condition for our security, i.e., the development of the nuclear industry. The Government cannot do this at all satisfactorily. It is not an engineering concern. Every dollar spent by the Government in encouraging industry to enter this new field will be worth ten dollars spent by the Government's trying to do it itself. We cannot expect it to have all the know how of drawing aluminum tubing, smelting uranium metal, manufacturing graphite. We must open the new field to all qualified industries and promote a healthy competitive development. That is the way our security lies, and the engineers are the ones who will bring about this development.

SOME OBSERVATIONS ON WORLD INDUSTRIALIZATION

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PART I

ENGINEERING AND THE TIMES

IN normal periods, and in accordance with usual custom, the engineer is engaged on assigned tasks. His plans are worked out in the light of existing and measurable conditions. But the engineer's plans heretofore have not been supposed to comprehend social and political factors.

Practically all peacetime engineering has been based on a relatively static situation both in the immediate environment and in the world at large. It has been pretty largely the engineering of materials and material forces, conditioned in varying degrees by the employer-employee relationship. It has not included what might be called the engineering of peoples, affected as they are by imponderables not to be calculated on the slide rule.

In view of the total world situation there is today an expanding field of opportunity for the engineer, one in which he can function with an ever-higher order of authority. Because of the promised widespread use of nuclear energy, the vast growth of facilities for international communications and transportation, the rising tide of education, the coming together of the nations in new and higher types of international co-operation, and other developments in the life of man on this earth, the engineer, if he is to maintain and increase his prestige and usefulness, will be forced to make his designs in the light of social conditions yet to be brought about. He must take his place in those echelons of political and social planning where continent-wide and even global undertakings will increasingly be thought out. In some cases the realization of objectives will seem to be discouragingly distant. This, however, is the niche for the engineer to fill if he is to play any important role in the solution of large-scale and pressing problems—some of which challenge even the survival of the race.

Under such a concept of engineering the profession might well assume as a task fitted to its wide range of technical competence an attack on the paralyzing poverty that to a considerable extent needlessly blights the lives of perhaps one half of the world's 2 billion and more of people. Definitive master techniques for poverty abatement are not known. Their study with human welfare as the dominant incentive has hardly begun. Seemingly the most promising over-all attack on this devastating penury is to be found in widespread and better-balanced but socially minded industrialization. The engineer has considered the mechanics involved as a field peculiarly his own. Economists, scientists, diplomats, businessmen, politicians, medical men, and other professional groups each will continue to have their specialized parts to play in this far-flung and inspiring endeavor. But this does not relieve the engineer of a primary responsibility. My own management engineering group may well make the initial moves.

Here undaunted optimism is the only key to success. Fears and apprehensions or even too many seemingly relevant reservations will spell defeat. We need the inspiring attitude reflected in the slogan of the Sea Bees (C.B.—Construction Battalion of the U. S. Navy, Corps of Engineers) as epigrammatically used in World War II: "The difficult can be done at once—the impossible takes a little longer."

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PART II

THE PROJECT

The poverty and suffering of peoples is reflected by many different indexes and follows a pattern that is seldom uniform throughout a given area. Pools of relative plenty dot vast regions noted for human squalor. Within even highly organized cities in the industrialized United States on the one hand and in agricultural Brazil on the other are to be found spots where human life exists at unbelievably low levels. In various parts of the world, but especially in Europe, similar areas have resulted from war's devastation. But generally speaking, it can be shown that industrialization implies a relatively high level of living. So we can use as an index in the delimitation of our problem the estimated percentages of the population dependent on agriculture of the several continental areas, Table 1.

There is happily considerable evidence in support of the conclusion that substantial benefits will accrue to agricultural

TABLE 1 PERCENTAGES OF POPULATION DEPENDENT ON AGRICULTURE

	Total population[a] (000's)	Population dependent on agriculture: Population (000's)	Population dependent on agriculture: Per cent of total
World	2,029,435	1,188,295	58.6
Europe[b]	373,673[c]	135,770	36.3
North America[b]	133,496	34,031	25.5[d]
Tropical Latin America	90,941	67,286	74.0
Temperate Latin America[b]	17,953	6,286	35.0
Asia	1,091,623	746,071	68.3
Africa	143,017	109,882	76.8
Australia and New Zealand[b]	8,265	2,031	25.0
U.S.S.R.	170,467	86,938	51.0

[a] The totals for the world are not as high as the present assumed total of 2,170,000,000 because it has been necessary to use earlier population totals and estimates for occupations.

[b] The percentages of the total population dependent upon agriculture are lower for Europe, North America, Temperate Latin America, and for Australia and New Zealand, because of the large proportion of the population in the cities of these areas. North America includes the United States, Canada, Alaska, Newfoundland, and Labrador, and Temperate Latin America includes Argentina, Chile, and Uruguay.

[c] This figure is the summation of the U. S. Census 1930 figure, Canada, 1931, Newfoundland and Labrador, 1935, and Alaska, 1929, these enumerations being for this group the last containing occupational data.

[d] In 1940 the U. S. alone had an estimated 23 per cent of its total population dependent on agriculture. As estimated for January, 1945, about 18.1 per cent of our total population was on farms. Of the total number of gainful workers in the U. S. A. 10 years of age and over, approximately 18.8 per cent were engaged in agriculture in 1940, in contrast with 64.5 per cent in 1850, and 71.9 per cent in 1820.

peoples through industrialization, accompanied as it usually must be with improvements in transportation facilities. Economists hold that practically every increase in industrialization can be spelled out in terms of higher levels of living. It has been shown[1] that there are standard differences in per-capita income for similar differences in the degree of industrialization. The evidence of this is to be found in the income data for the several states of the United States and for the various countries of the world. Thus, in the several regions of the U. S. the difference between per-capita income in states having 40 per cent of their workers engaged in agriculture and those having only 20 per cent is a difference of about $200 (1939 prices), or a difference of 80 per cent for Southern states and 50 per cent for Northwestern states. For Europe, Latin America, and Asia also the difference between 40 per cent engaged in agriculture and 20 per cent is a difference of about $200 (average prices 1925–1934). For certain of the undeveloped portions of the world this would mean more than doubling the per-capita income.

Furthermore, it is asserted that such betterments can be consciously planned, and that substantial results have actually been achieved by such planning. For instance, it appears that the U.S.S.R., through state action, made as much of a shift from an agricultural to an industrial economy in the one decade, 1929 to 1939, as had been achieved without over-all planning in the United States in the last four decades of the nineteenth century.[2]

More evidence as to the effect of industrial development on levels of living may be adduced from the relationship between energy consumption for productive purposes—a prime index of industrialization—and national income. Certain studies conducted within the United States Government have shown how close this relationship is. The same studies have also shown that there is a direct, but less precise, relationship between *total* energy consumption and per-capita income.

Some idea of this range in energy consumption for productive purposes (1937) and its reflection in per capita income (1925–1934), may be gained from Table 2, in which are listed representative areas comprising a wide range of living levels. The table also contains the corresponding percentages of actual workers in the total working population (1930). These percentages are, of course, highly correlated (inversely) since increased use of nonhuman energy is usually accompanied by a relative increase in nonagricultural activities. The relationships would be even more striking if the three sets of data had been available for the same years.

In addition to these real economic gains enjoyed by the whole population, there appear to be certain advantages—some of them psychological—accruing to the individual agricultural worker through being exposed to the influence of an advancing industrialization. It is common knowledge in the U. S. A. that since the coming of the tractor and the automobile our farmers have become more mechanically minded and more tool-conscious, more discriminating in the choice of tools and more competent in their use. Tractors and cars bring repair shops, in many instances leading to the small beginnings of local industrialization. From there on the talk of the district is apt to include mechanical discussions, sometimes acrimonious, along with more desultory observations on crops and the weather. Then follow the beginnings of a more conscious and advanced type of planning. It is admitted that one may not change the weather, but the ways of circumventing its bad effects are increasingly studied. So "acts of God" against which man is unable to compete become less frequent. Such a drift in a people's thinking may be more important than that wrought by more orthodox education.

That our intensive American industrialization increasingly influences farming practice for the better is a weighty argument in this discussion. American commercial farmers, producing goods for the market, are as a class and hour for hour the most efficient agricultural workers in the world. Their output last year had nearly a 21 billion dollar value. The labor-saving equipment that made this possible includes small grain combines, rubber-tired tractors, multirowed cultivators, mounted corn pickers, field choppers, tractor and truck buck-rakes, flame-throwing cultivators, cotton pickers, tree shakers, and other devices. The greater availability of electricity on the farm in recent years has made easier and more satisfactory the use of refrigeration, milking machines, water systems, brooders for chicks, pigs, and lambs, elevators for grain and hay, grinders, hot beds, and lights for increasing egg production, and made possible the barn haydrier.

Mechanization alone, however, is not enough. With all the machinery that has been brought in to increase the productivity of American farms, farmers in the United States are still faced with the problem of paying higher wages, confronted as they are by diminishing soil fertility and increasing fixed costs.

TABLE 2 ENERGY CONSUMPTION AND INCOME

Area	Per-capita consumption of energy for productive purposes[a]	Per-capita income[b]	Percentage of agricultural workers in total working population[c]
World	1,250	121.0	..
United States	7,000	508.0	22
United Kingdom	5,500	465.0	6
Western and Central Europe[d]	3,630	310.0	26
France	2,800	298.0	36
Japan	1,250	114.0	50
Eastern and Southern Europe[e]	827	109.0	63
Bulgaria	350	83.0	81
China (excluding Manchuria)	170	22.0	80

[a]The kilowatthour electricity equivalent of all the energy obtained from coal, oil, fuelwood, peat, and natural gas; the derivatives of these fuels (gas, gasoline, coke, thermal electricity, etc.); hydroelectric power and the efforts of men and draft animals. Fuel and power used for house heating have been excluded in so far as possible. It is assumed here that only 20 per cent of the free energy available in fuels is actually recovered. The data of reference are 1937 with the exception of Spain (1935) and Japan (1936). These years were selected as representing most recent normal peacetime economic conditions in both countries.

[b]Equivalent dollars per year calculated from Colin Clark, "The Conditions of Economic Progress," London, 1940. Income of China independently estimated. The data are averages for the years 1925–1934. This period included what may be regarded as an entire trade cycle with about the same number of boom and depression years.

[c]Includes fishing, hunting, and forestry. Calculated from official census data for various years, largely since 1930.

[d]Sweden, Norway, Denmark, United Kingdom, Eire, Netherlands, Belgium, Luxembourg, France, Switzerland, Austria, Germany, and Czechoslovakia.

[e]Finland, Estonia, Latvia, Lithuania, Poland, Hungary, Rumania, Bulgaria, Greece, Yugoslavia, Italy, Spain, and Portugal.

[1] See "International Industrialization and Per Capita Income," by Louis H. Bean, Part 5 in Studies in Income and Wealth, published by National Bureau of Economic Research, New York, N. Y., 1946.

[2] Premier Stalin on Feb. 9, 1946, asserted that in planning the recent industrialization of U.S.S.R. the Communist Party had chosen to develop heavy industries as contrasted with the lighter consumer-goods industries which latter he claimed had been heretofore the universal pattern for industrial development. He further gave it as his opinion that this quite general adoption throughout the world of consumer-goods industries was dictated by the smaller capital requirements. It presumably follows that to industrialize in the first instance through heavy-goods industries there must be a will on the part of the people or their government to hold in check or restrict the use of consumer goods.

There must also be available the energy resources requisite for heavy industry, but many areas requiring industrialization do not have such resources of sufficient magnitude for this purpose. It is possible, for instance, that Italy has unduly expanded her heavy industries since she is forced to import 60 per cent of her energy resources either by sea or over the Alps.

These problems must be met with better production planning, more economical use of land and equipment, and easier and simpler methods tied into the newer technological developments—techniques bound to be adopted in any agricultural economy utilizing a mechanized program. A move in this direction has already begun, in the form of a national farm-work-simplification program carried on by 12 of the land-grant colleges. The program has already shown that about the same savings of time and energy can be made in argricultural jobs as in industrial jobs.

Yet with all the technical advice and governmental assistance that has been available to farmers in the United States, practically none has been comparable to that supplied currently to industry by a vast army of industrial engineers. Yet the operation of an average American farm has today become so complex that the individual farmer could use, and in fact absolutely requires, a large measure of the same type of planning and management techniques available to his cousins in industry. It is high time that the growing group of agricultural engineers seize the opportunity to introduce the philosophy and some of the practices of Frederick W. Taylor and scientific management into agriculture.

Because energy resources translated into mechanical power are the touchstone of industrialization, the development of energy resources is particularly desirable in countries lean in other so-called natural resources,[3] for these are the countries least able to support their people adequately by employment in the primary industries alone. Energy not only enables them to branch out into the processing and transportation industries that characterize better-balanced economies; it also creates the opportunity to synthesize some of the raw and semiraw materials they lack, such as nitrogen compounds, rayon and staple fibers, dyes, stains, and rubber.

There are some, perhaps, who question the wisdom of promoting industry in areas that now provide so much of the world's raw materials. But, in so far as energy resources are adequate for such development, it offers only good, not only to the undeveloped areas themselves, but also under proper trading arrangements to the countries that now see in these areas only markets for their manufactured goods.[4]

Inanimate energy means increased productivity of individuals and in the long run, lower prices for what they have to sell. The development of the United States has been marked by phenomenal rises in wages; increases in the productivity of labor in the United States, which here made the wage increases possible, have been even more phenomenal. The net result has been, in general, a constantly decreasing unit cost of many of the things we consume.

The explanation of this paradox lies in the relative inexpensiveness of energy from inanimate sources. Fantastic as it may seem, a kilowatthour of electricity which will keep your 60-watt bulb burning for 16 hours at a cost of perhaps one cent, will do more work than most men can perform in eight hours of real hard labor.[5] A ton of coal, worth roughly $3 at the pithead, can be made to do more work than 500 men can perform in six working days of eight hours each.

Both engineers and scientists appear to view with confident optimism the utilization of the split atom as a source of controlled energy, especially for power-generating stations. In fact, this great quest of the race has already been begun. Heat in the volume and under the controlled conditions required for the generation of mechanical energy is already being produced through nuclear fission. Further it seems likely that this new source of power will first be developed for use in novel situations or in sparsely populated areas away from the normal haunts of men where, because of expense or for some other reason, the usual power sources are unavailable. If the promise of these early beginnings is fulfilled, the task outlined in this paper will be very greatly simplified, but it seems wise to base conclusions in this discussion on immediately available resources. France, endowed by the inspiring Curie tradition, has shown her confident faith in the outcome by appropriating $12,000,000 for nuclear research with Joliot-Curie in charge.

Generally speaking, the industrialization of any nation or area is largely dependent on the energy resources actually within that area or fairly near at hand. Over longer distances transportation costs are prohibitive. World-wise only 13½ per cent of the world's energy and fuel supply crosses national boundaries. And while half of this is oil moving from a few great centers to all corners of the globe, most of the remainder is coal moving short distances between countries already industrialized—from Britain and Germany to France, from the United States to Canada.

The world's coal is largely concentrated in a dozen countries. Most of the economically undeveloped regions of the world are relatively lacking in coal, and likewise remote from other coal-producing areas. In Africa, only the Union of South Africa has substantial coal reserves, and such reserves are negligible in most of Middle America, South America, the Pacific Islands, Western and Southeastern Asia. They are relatively unimportant in much of Eastern and Southern Europe.

Fuel wood, while widely and in some cases—such as Brazil—profusely distributed in the industrially retarded areas under discussion, is an inefficient energy resource. It is commonly held in Brazil, for instance, that wood-burning power stations cannot be operated more than six hours in a day. Similarly peat plays only a negligible part in economic development. Wind power in restricted areas such as northern Russia is gaining ground. But wind as a generally available source of energy must for the present be discounted.[6] Oil has such high value as a source of energy for transportation in ships, automobiles, trucks and even locomotives, and as a lubricant, that it has become too costly for any considerable use for power under the vigorous competitive conditions which obtain in most industries today.

Seemingly hydroelectric power will prove to be the prime factor in the industrialization of areas not now enjoying a satisfactory level of economic well-being. Most such areas have at least modest reserves of water power. In fact most of them have little else except forests, or wind, or possibly oil, none of which can be considered for reasons already stated. Fortunately, some of the world's greatest water-power reserves are in these less advanced countries. But in spite of their potential significance, only a tiny part of these reserves is being utilized today. It is conservatively estimated that the world's total water-power resources are capable of yielding some 4000 billion kilowatthours of electricity annually, approximately as much energy as is now obtained annually from all sources. Only one twentieth of this type of energy has thus far been put to work.

In addition to power, hydroelectric projects would bring to these undeveloped areas certain recognized values in navigation, irrigation, and flood control. They would also afford an all-round opportunity for giving local labor some of the training required to fill jobs in a mechanized civilization. As a

[3] See "Resources—An Evolving Concept," by Erich W. Zimmermann, professor of resources at University of Texas, Proceedings and Transactions, Texas Academy of Science, 1944, vol. 28.

[4] See "The Economic Consequences of Power Production," by Fred Henderson, John Day Company, New York, N. Y.

[5] For instance a man turning a crank continuously for eight hours puts out less than 1.3 million foot-pounds of work. (See Marks' Handbook, fourth edition, p. 1131). This is roughly the work equivalent of two thirds of a kilowatthour of electrical energy.

[6] See "Electric Power from the Wind," by Percy H. Thomas, Federal Power Commission, Washington, D. C., March, 1945.

large percentage of the funds needed for hydroelectric plants goes into the purchase of local materials and local labor, a total investment of several times the original amount may be generated before the loan is repaid.

When these projects are small decentralized units, thought of in most instances as elements in an ultimately integrated system, they will prove the desired leaven in the total situation, training local people at all levels in the more effective ways of industry, and thus making each such plant part and parcel of the advancing democratic life. A few relatively small developments more or less model from this point of view will give our movement a world-wide impetus far stronger than that which might be expected to result from larger and more bizarre enterprises such as the suggested billion-dollar power plant on the Yangtze River in China. Large power instruments eventually find economic justification—after a considerable measure of industrialization has been achieved,[7] and a corresponding purchasing power developed. But beginnings of industrialization should be through smaller power units locally, as was the case in the United States during the early nineteenth century.[8]

Excessive regard for the large and neglect of the small have been a constant blight on civilization's progress. The vast temples that have been built in each period of man's history have undoubtedly inspired men's souls but they have frequently been built with little thought as to the humble homes and the living conditions of the masses.[9] With the invention of the steam engine, and the rise of the Industrial Revolution, there ensued a demoralizing concentration of the industrial population near by the power station. The electric transmission line theoretically freed us from the limitations of the line shaft and the leather belt. But nevertheless our industry still piles up geographically in such a way as to make decent living for the workers very difficult. Such congested centers in the United States as Pittsburgh, Detroit, and Schenectady make the introduction of anything approaching a spiritual quality into industry well-nigh impossible. So careful planning of the environment must be a part of every one of the proposed installations. Urbanization as we have known it must be avoided. The Swiss on the River Aar[10] have demonstrated how effectively this can be done even in a heavily industrialized area.

The main purpose of industrialization, particularly in the less prosperous areas, should be to build up local purchasing power so that locally grown agricultural products can be consumed locally while manufactures and excess agricultural products are exported in exchange for needed imports of consumer goods, to buy more machinery and to pay off loans. But this has not been the usual pattern in industrialization. Shanghai, for instance, appears to be a prime example of a distant industrialized people exploiting a distant agricultural people for the former's advantage, not the latter's. This is not an example of developing, it is an example of exploiting a backward people.

Here modern machinery was brought into a reservoir of cheap labor. Products were then manufactured at low cost but sold primarily on a foreign market yielding foreign credits. Shanghai did not buy the major portion of its food supply from Chinese farmers. Shanghai bought most of its wheat, not from Chinese farmers, but in foreign markets. The same was true of rice to a somewhat lesser extent. Chinese farmers, on the other hand, produced little more than enough for themselves and their families. They had almost no surplus crops for exchange or for sale. Consequently, their purchasing power continued to be low and they were unable to buy many of the products of Shanghai's industries.

If the industrialization of China or any other area follows this pattern, then the farming population of China—more than 350 million people—will be left to little more than subsistence agriculture with its implications of low purchasing power. From that it could easily become a bedding ground of social unrest and even revolution. But if the industrialization of China follows a pattern of decentralization of consumer-goods industries, a more hopeful situation is in prospect. Farmers will gradually gain purchasing power, not only as a result of increased productivity but as a result of the increased demand of the workers in industry, to support the further industrialization of the country including some heavy industry, and the social structure throughout will become more stable.

There are some who hold that population must be under control before industrialization will benefit peoples with unsatisfactory economies. This argument appears to be based on the theory that an increase in income in depressed areas necessarily results in larger families and therefore larger populations and more distress. But experience in the United States, England, France, and Czechoslovakia indicates that as the situation of the individual worker improves, smaller families become the rule and voluntary population control a part of the demographic pattern. The rate of natural increase in the United States population has declined steadily in conjunction with a constantly rising level of industrialization. According to the U. S. A. Census Bureau "as education goes up birth rates go down"—the education including in varying degrees among the several economic groups "knowledge as to the means of controlling the birth rate."[11] With 20,000,000 displaced people at the end of World War II we are in process of learning something about the techniques of moving populations—both as emergency as well as long-term measures. We should have in mind that there are areas needing population just as there are overpopulated areas.

Now for a summary on a global basis. The One World we live in today is inhabited by something over 2 billion human beings, supported by the work of some 800 million. Of these 800 million sixty per cent, or nearly 500 million persons, are now engaged in tilling the soil. Any world-wide program of economic development must be designed to reduce this number by one third, and it can be effected only by creating new and attractive opportunities in other fields of endeavor for more than 150 million of the people now employed in agriculture. The industrialization of undeveloped areas affords one means of achieving this objective. We cannot expect to create 150 million new jobs in industry, but every job that we do create in industry means also a new job in the tertiary occupations—transportation, trade, or services. If we can create perhaps 75 million new jobs through the industrialization of undeveloped areas, then we can double living levels in those areas, and raise the world average by at least 50 percent.

Can the United Nations have a more inspiring objective than this? In its accomplishment our profession, still in its adolescence, may find a new level of being.

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[7] The U.S.S.R., even with their heavy-industry program, made the mistake of building their first hydro installations too large.

[8] Hydroelectric developments make possible these small early installations. A listing of Japan's hydro plants, compiled during the war, shows that out of a total of 447 such plants 264 ranged from 1000 to 5000 kw, 73 from 5000 to 10,000 kw, 74 from 10,000 to 30,000 and 36 were over 30,000 kw. According to *World Electrical Markets*, No. 123, more than 80 per cent of Italy's hydroelectric power plants as late as 1934 had capacities of less than 5000 kw. Nearly 90 per cent had capacities of less than 10,000 kw and 95 per cent had capacities less than 20,000 kw.

[9] "From Rameses to Rockefeller," by Charles H. Whitaker, Random House, New York, N. Y., 1934.

[10] "Multiple Purpose Rivers," by Morris L. Cooke, *Journal of The Franklin Institute*, April, 1944.

[11] Population Bulletin of the Population Reference Bureau, vol. 2, nos. 1-2. January-February, 1946.

PART III

PATHS TOWARD ACCOMPLISHMENT

Having set a few of the stakes outlining the projected task, how do we proceed? The changing pattern of international relations calls for a change in our thinking. We engineers in common with other groups—the scientists, for instance—must "reassess our role in civilization," we must become more community minded.[12] The front office, the shop, and the laboratory—traditional lairs of the engineer—may remain dominant in our lives, but now we must acknowledge the need for participation in community affairs—local, national, and international—as leaders or high privates, as the case may be. The techniques by which we shall become citizens in this new and broader sense will be varied, but most of them will become quite obvious once the obligation and opportunity are admitted.

One direct result of this changed attitude toward the common life of mankind will be the breaking down of many of the bulkheads that now separate our specialisms and their practitioners. The engineering profession will not only close ranks, but the mutual dependence of the various engineering disciplines and the myriad ways in which they complement each other will become increasingly apparent. The sharp lines of demarcation between our national engineering societies—mechanical, electrical, civil, and chemical—certainly the rule in England and the United States—will soften as the areas they cover merge or overlap at their outer edges. The several specialties, of course, will persist. National engineering federations will become generally possible. Then for the first time will a well-knit and competently functioning international federation of engineering societies becomes feasible.

The next, and perhaps the most difficult step will be for engineers and their organizations to become conditioned politically by constant association with their own national legislative bodies and their politically minded members, and with the executive departments of the national government—such as Foreign Affairs, Commerce, Interior, and Agriculture—the departments in the future to be concerned with matters affecting industrialization, national and international. Such contacts between engineers and government are common in some countries—Czechoslovakia, for instance—but they are relatively new in the United States.

Finally, as we become more internationally minded we can set up our lines of contact with the United Nations Organization and its various agencies, particularly those like the Social and Economic Council and the proposed International Trade and Employment Organization that have a special interest in world-wide industrial development. One step in this direction has already been taken. The international group of scientists that recently went to London was completely successful in having the name of UNESCO[13] changed from the United Nations Educational and Cultural Organization to the United Nations Educational, *Scientific*, and Cultural Organization, thereby obtaining amplified recognition for scientific objectives.

Diplomatic usage of course suggests a meticulous recognition of the various echelons of interest and authority—nations, colonies, dominions, mandates, trusteeships, and what-have-you. But once engineers have familiarized themselves with this hierarchy, constituting the family of nations, short-cuts in obtaining official consideration for proposals and even for the execution of projects will doubtless be discovered. For example, an early move might be made by urging the Economic and Social Council of UNO to set up a general staff of technicians, charged with responsibility for exploring the means of furthering industrialization, advising on problems of economic development, and giving other assistance as the occasion may demand. Such an agency for peace might have a setup somewhat comparable to the Allied Chiefs of Staff during World War II.[14] As our data are fully interchangeable, engineering on an international basis should be relatively easy.

Fairly liberal financing for some projects of this type has already been provided by private American interests. On other occasions financial support can be obtained through national treasuries and from the International Bank for Reconstruction and Development provided for in the Bretton Woods agreement. Under Article IV, Section 7 of this agreement, all loans involving construction must be approved by a board of technicians. Our own Export-Import Bank as a rule makes the employment of American engineers a feature in loan contracts.

Education must be a large part of this program. As the teaching staffs of engineering schools throughout the world become conditioned to a world point of view, and their studies of society as expressed in their increasing insistence on the social sciences in drafting curricula, colleges and universities can be utilized as rather ideal research centers. They can serve as focal points for the study of almost any specific proposals for industrialization, hydroelectric or other. Each such study will prove especially attractive to young people because it will have a tendency to tie them in with the throbbing life of the times. And studies of this sort, associated with the program of action advocated in this paper, would have a special appeal.

Coming in from schools all over the world to some designated center, such studies would in themselves constitute a sizable contribution to world understanding, especially if they could be supplemented by international engineering conferences. There should also be created a nonprofit Institute of River Valley Development standing quite aloof from the diplomatic handicap of a governmental agency.[15] If even a small percentage of the engineering organizations of the world could be induced to hold one session, or contribute one single paper, once a year, a prodigious amount of material and influence would result therefrom. Thus in time the good life in town and country would become the background of broader engineering thinking.

My own country is already equipped to make an outstanding contribution to this enterprise by making available data on all types of industrialization projects. The building of a vast hydroelectric project on the Tennessee River,[16] resulting in highly significant economic and social developments as conceived of and fostered by those two great Americans, Franklin D. Roosevelt and George W. Norris, has been described by many writers and in many languages. That it has served even more directly as an inspiration to the rest of the world is attested by the fact that representatives from over 50 nations have visited the Valley and technicians trained by TVA are to be found in all corners of the globe.

(*Continued on page 453*)

[12] "Science for Democracy," by Ward Shepard, *Science*, Jan. 18, 1946, and "Science Knocks at the Door of American Politics," by Morris L. Cooke, MECHANICAL ENGINEERING, vol. 67, 1945, pp. 569–571.

[13] See "The Charter and Challenge of UNESCO," by Harlow Shapley, *The American Scientist*, January, 1946.

[14] Some idea of the widely ramifying operations in this field may be gained from the fact that the Tennessee Valley Authority lists among its employees about 150 different technical positions, such as aquatic biologist, biologist, botanist, chemist, community planner, economist, entomologist, epidemiologist, forest ranger, geologist, land appraiser, librarian, malariologist, pharmacist, photogrammetrist, plant physiologist, statistician, and transportation economist, together with many varieties of engineers, such as cartographic, chemical, civil, cost, electrical, erosion, highway, industrial, mechanical, metallurgical, mining, navigation, rate, safety, structural, and valuation.

[15] See "Regional Development Projects Abroad," by Morris L. Cooke, "World Economics," vol. 3, nos. 11–12, Oct., 1945.

[16] See "TVA—Democracy on the March," by David E. Lilienthal, Harper and Brothers, New York, N. Y.

FLIGHT TESTING *of* JET ENGINES

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A CONSIDERABLE amount of information has been released lately on the subject of jet propulsion and on the design and uses of jet-propulsion engines for military aircraft, but the story of the work that has gone into making jet propulsion successful will cover many phases of the science of engineering. Thermodynamics, physics, fluid dynamics, metallurgy, chemistry, stress analysis, and aerodynamics, all are required to develop the jet-propulsion engine. Tests have to be conducted in each of these fields to attain the goal of a successful engine.

Having the engine operating and delivering thrust on a test stand in the laboratory, it is then time for it to show its mettle in the medium for which it was designed, in flight, in the air at high speeds, high altitudes, and high rates of climb. Many flight conditions can be reproduced in the laboratory by controlling the air pressure and temperature; however, it is virtually impossible for any laboratory to vary conditions rapidly as may be done in actual flight. This is the reason that flight testing is so necessary.

The flight-testing procedures and techniques required for those conditions will be discussed from the experience on the Navy program for flight research on the performance and operating characteristics of the Westinghouse Model 19A and 19B jet-propulsion engines at The Glenn L. Martin Company.

Early in 1944 the U. S. Navy sought means of expediting the performance testing and determination of the operating characteristics of the jet engine designed and built by the Westinghouse Electric Company. Test-stand runs of this engine had been made and had proved that its weight, fuel economy, and performance were excellent by comparison with existing jets. It would be a year or more before an airplane designed to utilize this engine would be flying and therefore valuable time could be gained by installing this engine in an existing airplane. A proposal to install one of these engines in a Navy JM-1 (B-26 type) airplane was made by The Glenn L. Martin Company. The salient features of the installation, operation, instrumentation, and safeguards followed in connection with that project will be discussed.

INSTALLATION FEATURES

Before describing the installation in detail, it would be well to emphasize the desirability of flight-testing jet-propulsion engines in a conventional airplane, modified to a flying laboratory. An airplane with main power furnished by conventional engines provides a flight laboratory capable of exploring engine characteristics under natural conditions of altitude and air temperature. The jet engine may be started, accelerated, operated, and stopped in flight without prejudice to the safety of the airplane crew. All combinations of engine speed may be investigated at various flight speeds and altitudes, and thus may be determined for the pilot of the jet-powered airplane the answers to many questions, such as: What is the recommended air starting procedure, and as found in many cases, can the engine be restarted in flight at all altitudes and air speeds? How fast will the engine accelerate? How much drag does a windmilling engine have? Will leaks develop under service conditions or at altitudes that were not apparent on ground runs? What minimum idling speeds must be observed to avoid stoppage or inability to accelerate?

Because of the versatility of the flying laboratory, many other flight programs may be undertaken. High-speed bombers of proved performance with their large load capacity, roomy crew quarters, and multiple engines have proved to be excellent for this work and the Navy's choice of the JM-1 has been a fine example.

In the installation to be described the jet engine was readily mounted in the fuselage at the rear gunner's station on a floating cradle restrained in the thrust direction by air-balanced diaphragm thrustmeters to isolate the knotty problem of thrust determination. Air is conducted to the face of the engine by two ducts from scoops on the lower sides of the fuselage at the waist gun hatches. The ducts join just ahead of the engine entrance. A firewall with a window through which to observe the engine is provided at the elevator spar bulkhead. The fuel is carried in a droppable bomb-bay tank, and the oil is carried in a special high-deaeration tank in the rear of the fuselage. The waist-turret position accommodates the test instrument panel, starting switches, fire-fighting equipment, and a test crew of three. Interphones are used for communication with the pilot and among crew members while in flight. No structural or balance changes were necessary since the engine weight was equivalent to the displaced guns, gunner, and armor. The design of such an installation requires that the laboratory nature of the tests to be conducted be recognized in planning the engine mounting, fuel, oil, electrical and instrument systems, and the test crew's accommodations (see Figs. 1, 2, and 3).

FLIGHT OPERATION

A typical flight-test program for ascertaining a jet engine's characteristics includes:

1 Starting and acceleration at various flight speeds and altitudes.

2 Performance, i.e., thrust, fuel rate, air flow, temperature measurements, etc., at various engine rpm, flight speeds, and altitudes.

3 Windmilling operation at various flight speeds and altitudes.

4 Functional tests of governing system in climbs and dives.

The job of the test pilot is to maintain the specified speed and altitude conditions of the airplane while the test crew operates the jet engine and observes its performance. A duplicate set of airplane instruments is included on the test panel to enable accurate correlation of jet and airplane conditions.

In order to obtain information on air starts, the intake ducts

Contributed by the Oil and Gas Power and Aviation Divisions and presented at the Annual Meeting, New York, N. Y., Nov. 26–29, 1945, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

FIG. 1 THREE-QUARTER FRONT VIEW OF NAVY JM-1 AIRPLANE WITH WESTINGHOUSE JET-ENGINE INSTALLATION

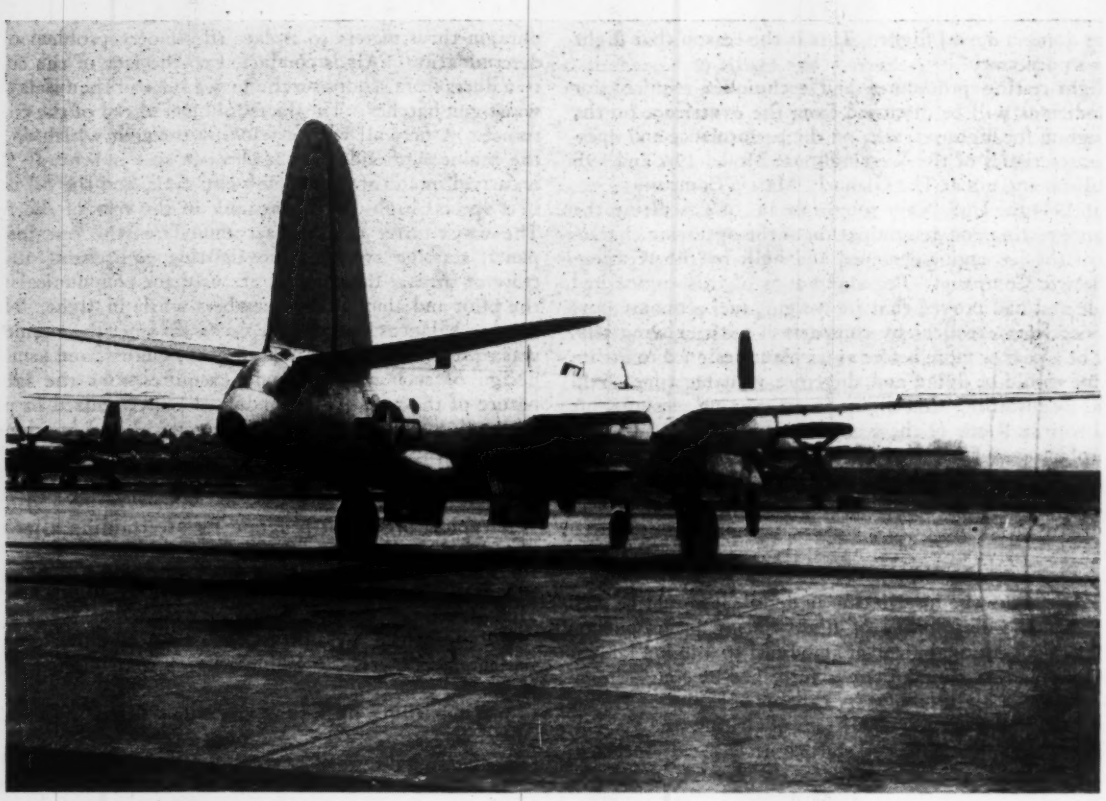

FIG. 2 THREE-QUARTER REAR VIEW OF NAVY JM-1 AIRPLANE WITH WESTINGHOUSE JET-ENGINE INSTALLATION

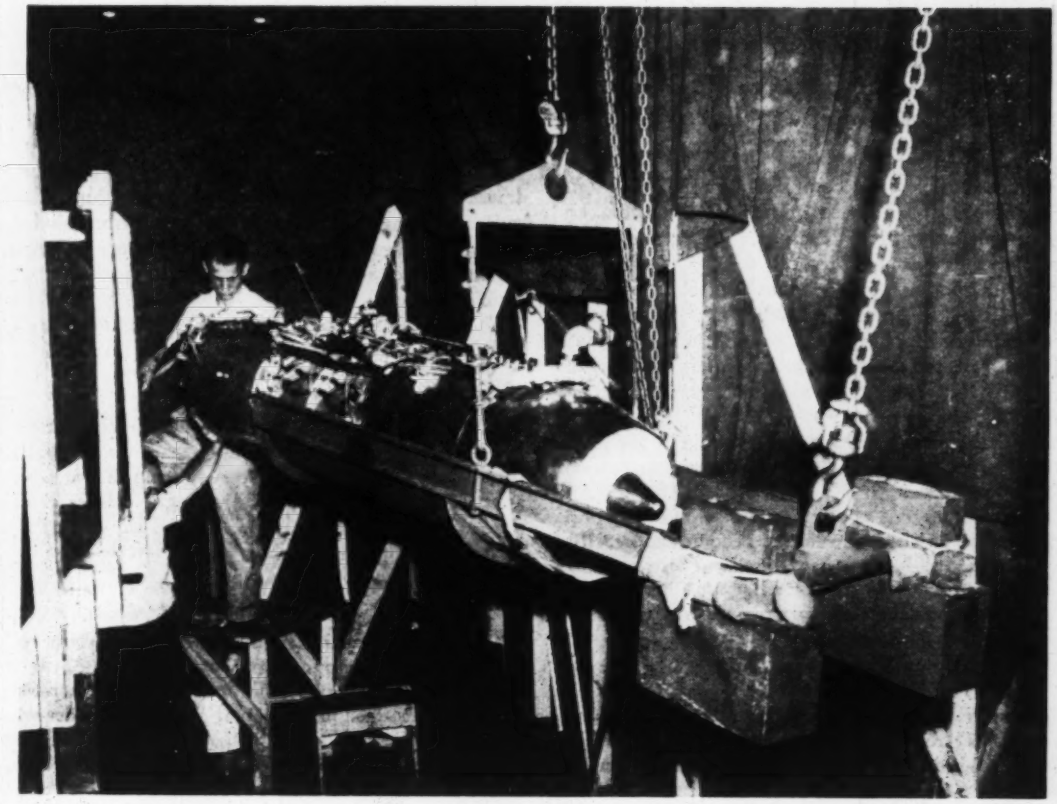

FIG. 3 WESTINGHOUSE 19A JET UNIT IN INSTALLING GEAR

are provided with manually operated butterfly valves which are opened at a given airplane speed. After the jet engine has reached its windmilling speed, the starter is turned on with the ignition and the throttle opened to supply fuel. Air starts have been obtained in this manner at indicated air speeds from 140 to 325 mph and at altitudes from 5000 to 20,000 ft. A start is considered successful when a stabilized idling speed is obtained and steady acceleration of the engine results from continued opening of the throttle. It has been found that most flight starts can be accomplished in 4 to 8 sec on this engine. Overeagerness in throttle operation results in an excess of fuel that will not light off or supply enough power to accelerate the rotor. The use of a conventional airplane for starting tests is an example of the type of investigation that is more safely carried on in the flying laboratory than in a jet-powered airplane and establishes the proper procedures and limitations of the jet.

During normal operation of the engine, acceleration time, fuel consumption, thrust, air pressure, and temperature distributions in the engine, effect of variable tail area, air flow, governor characteristics, and bearing temperatures are readily investigated and the data photographed or transcribed from the test instrument panel by the test crew.

INSTRUMENTATION

Provisions generally are included in test jet-engine installations for measuring the following quantities: Jet-engine speed; compressor-inlet pressure and temperature; compressor-outlet pressure and temperature; turbine-inlet pressure; turbine-outlet pressure and temperature; tail-pipe pressure and temperature; bearing and oil temperatures.

In addition to the foregoing measurements, which are of importance to the jet performance, airplane conditions are determined by the following instruments: Airspeed; altimeter; outside-air temperature; main engine: manifold pressure; torquemeter; tachometer.

Additional provisions must be built into the installation to measure accurately fuel flow, entrance-air flow, trunnion thrust, airplane attitude in pitch, static pressures and temperatures around the engine, and tail-pipe exhaust conditions (for gross thrust computations).

The gages for the items mentioned are mounted on a photo-observer panel in the test compartment.

The measurement of the air consumption of jet engines may be accomplished in several ways, i.e., by use of a calibrated nozzle, a sharp-edged orifice, Pitot-tube traverses, or an integrating pressure rake. The pressure rake is considered reliable, accurate, and free of nozzle-coefficient corrections and was therefore used.

The rake designed for testing the Westinghouse engine consists of 16 shielded hypodermic total-head tubes, arranged to average the total pressure of 4 concentric equal-area annuli of air flow. Static pressure is measured in the same plane as the total pressure by 6 flush static holes manifolded together. The air temperature in the duct is measured by a thermocouple and corrected to static conditions. With these quantities established, the air flow may be determined as follows:

$$Q = VA$$

$$W = \frac{Q \times P}{53.5 \times T}$$

where

Q = air flow, cfs
A = duct area, sq ft

V = true air speed (measured in duct and corrected for compressibility), fps
W = air flow, lb per sec
P = duct static pressure, psf
T = duct static temperature, deg F abs
R = gas constant

The measurement of thrust is accomplished by the diaphragm thrustmeters previously mentioned. The operation of this thrustmeter depends upon the balancing of air pressure, supplied by a compressed-air cylinder, or the jet compressor, against the load of the jet engine. Some hunting occurred in the initial installation, so hydraulic dampening cylinders were installed from the engine-mounting cradle to the airplane structure. The thrustmeters measure the axial thrust at the trunnions but require that corrections be made to bring the observed readings to the true engine thrust.

A correction force equal to the angular component of the engine and cradle weight must be added for variations in attitude of the airplane.

Another correction depends upon the summation of the pressures and areas of the jet engine itself and becomes appreciable in magnitude if there is a large pressure gradient along the exterior of the engine and accessories, or when a baffle, fire seal, or some such obstruction causes a local pressure differential.

Fig. 4 shows the instrumented test compartment.

SAFETY FEATURES

Engine fires must be provided against and two axiomatic requirements are: (1) A means of detecting them; and (2) a means of extinguishing them. The most straightforward method of detecting a fire is for the observer to be able to watch the engine under operation for signs of flame or smoke. This was accomplished by including a window in the fire wall separating the engine from the test compartment. The engine compartment contains spray tubes connected to three CO_2 bottles located in the test compartment where the CO_2 may be released by any member of the test crew.

The fuel flow is controlled in several ways which act as safety devices. In case the jet throttle does not shut off the fuel because of accident, an electrical fuel valve, operable by either the test crew or the pilot, prevents the fuel from entering the engine. A manual fuel shutoff valve is also provided at the jet-engine control station.

Thermocouples in the jet-engine compartment are used to determine the effectiveness of the engine insulation and of the ventilating air flow in keeping the structural temperatures within safe limits.

Adequate ventilation of the jet-engine compartment is provided to minimize any explosion hazard due to fuel leaks. Air is bled into the engine compartment from the intake duct. Exit area around the tail cone and exit gills assure ventilating air flow. The tail nozzle extends beyond the end of the airplane to prevent drippage of fuel from the nozzle from collecting in the airplane.

CONCLUSION

Flight testing of jet engines in airplanes with conventional engines is expeditious, inexpensive, and safe. It provides a method whereby service and operational characteristics can be readily determined in the actual conditions under which the jet engine will be called upon to perform. The foresightedness of the U. S. Navy Bureau of Aeronautics in actively prosecuting this work is to be highly commended.

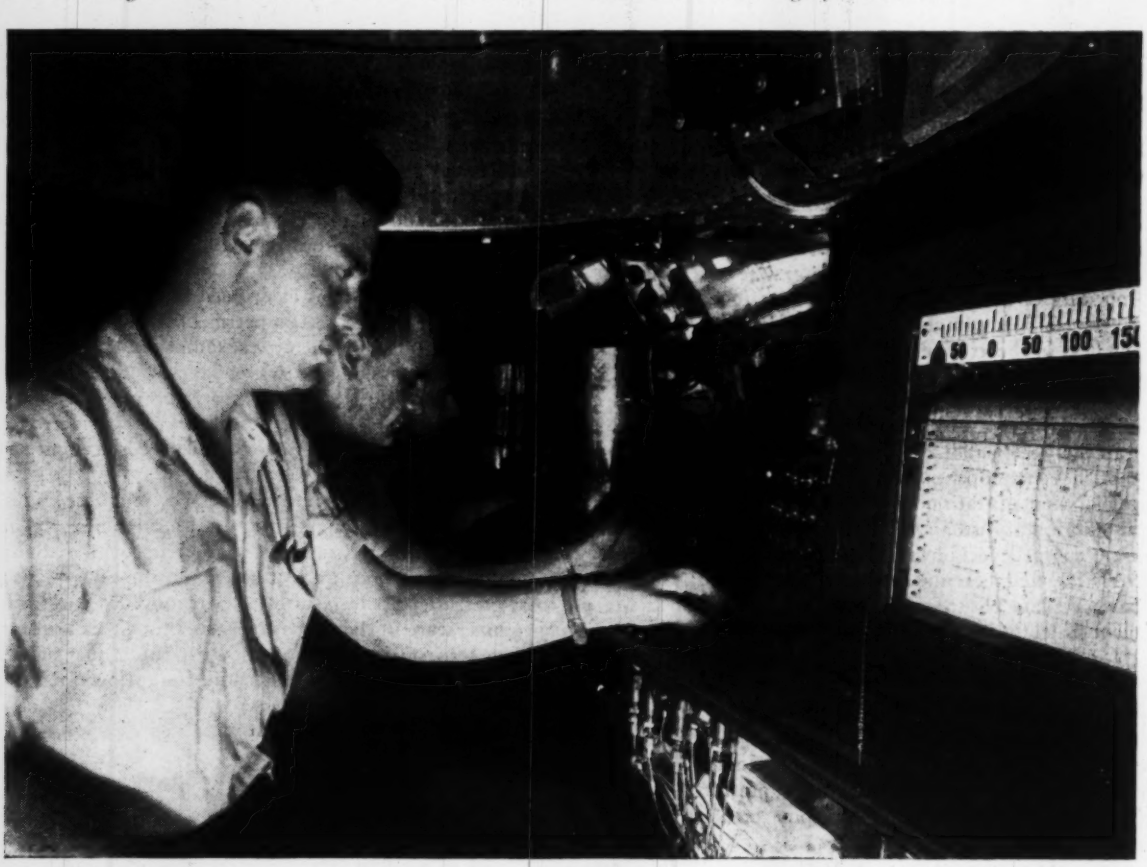

FIG. 4 FLIGHT-TEST ENGINEER'S STATION WITH OBSERVERS IN POSITION; VIEW LOOKING AFT

Handling SINGLE-POINT TOOLS *at* WATERVLIET ARSENAL

By E. G. MOFFAT[1]

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A GREAT amount of information has been written and published on the design, application, and use of sintered-carbide tools. Anyone desiring to apply sintered carbides could refer to these publications and, generally, obtain good results. Conversely, little has been written on the handling of carbide-tipped tools, and it is supposed the reason is that each user has a different problem and a system worked out to cover his particular needs.

In this paper no attempt will be made to cover the handling of negative-angle milling cutters or the carbide gun-boring reamers, as these tools are usually limited to specific operations, particularly the carbide boring reamers which are, so to speak, "tailor-made." These tools do not present the major problem that the single-point tool does.

Carbide tools are expensive and to the larger user they represent a large dollar tool inventory. Before the adoption of the present system at the Watervliet Arsenal, there were several thousand single-point carbide-tipped tools in circulation at one time. Our daily requirement amounted to the handling of 2000 lathe tools. As the production schedules of the arsenal increased, it became evident that our greatest problem was that of handling single-point tools to insure that each operator had enough tools at all times so as to prevent a stoppage of production; therefore handling of tools was of utmost importance.

FORMER SYSTEM OF HANDLING SINGLE-POINT TOOLS

Under the earlier system all carbide tools originated in the carbide section of the grinding department where the carbide blanks were brazed to the tool shanks. The unground tools were then placed in a storage crib and held for later distribution to the various grinding sections in each machining department. These grinding sections were equipped to grind and service all types of high-speed steel and carbide tools except the gun boring-reamers which were and are still handled in special reamer sections. The tool cribs received the new or reground tools and distributed them to the operators upon receipt of dull or broken tools.

The receiving-tool-crib attendants turned over the dull and broken tools to the department grinding sections which were located adjacent to the tool cribs, where they were inspected and then reground or scrapped. To replace scrapped tools, the cribs called on the carbide section of the grinding department which furnished unground tools. These were forwarded to the machining departments' grinding section for grinding and issue through the cribs. The only advantage this system afforded was that tools were always transported unground, and handling damage was nil. This advantage was far outweighed for the following reasons:

1 The highly skilled grinding employees in these grinding sections were being called upon to do rough and low-skilled grinding.

2 Machine operators were going directly to the grinding sections and were having nonstandard angles ground on tools, which resulted in shorter tool life.

3 Tool chasers, machine operators, and crib attendants were taking tools to the grinding sections and waiting there until the tools were reground. This lowered the efficiency of the grinding section and also resulted in a loss of manpower.

This system, while simple, was inefficient in that it lacked a proper distribution of tools which, in turn, resulted in an overly large inventory of tools accumulating in the shop, and a shortage of tools at machines, particularly on night shifts.

A survey was made of the single-point tools to determine what improvement could be made to correct the tool situation. This study showed that each lathe operator turning gun tubes required an average of 10 lathe tools per shift and that there were in circulation over 5000 carbide-tipped lathe tools. Based on the tool demand in each shop, a definite tool allotment was set up for each issuing crib. A further study was made of the sizes of tools required, and it was determined that all gun turning, at that time, could be handled with two sizes of tools, $^{15}/_{16} \times 1^{1}/_{2}$ and 1×2 both in left- and right-hand tools. These two sizes were standardized and all others eliminated. An analysis of the manpower revealed that 35 grinding operators were required per thousand tools ground and that our requirement for each 24 hours necessitated the grinding of 2000 carbide lathe tools.

As a result of this study it was decided to centralize in one area on a production-line basis all the grinding of carbide lathe tools. Layouts were completed and machines brought in from the various grinding sections. The layout showed that by operating two shifts with 14 people on each shift, 2000 tools could be ground in a floor area of 600 sq ft.

NEW SYSTEM PUT INTO OPERATION

To place the new system in operation the method of handling tools was changed. The tools are now directed from the tool cribs, in lots of 50 to 100, to the new grinding section where they are received by the sorter, who checks in the tools and issues a like number of ground tools to be returned to the tool crib. The sorter inspects the tools and separates them into three categories which are handled as follows:

1 Tools which can be reground are placed on a pallet on the conveyer in lots of 10 for movement to the first operation.

2 Tools with badly chipped or broken tips which require new tips are routed to the brazing room for retipping.

3 Tools which are too short or badly damaged are sent to the salvage department to be scrapped.

To maintain the proper quantity of tools in circulation, the sorter replaces the rejected tools with unground tools taken from stock. This system maintains a balanced flow of tools and automatically keeps the inventory at the proper level.

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Contributed by the Production Engineering Division and presented at the Annual Meeting, New York, N. Y., Nov. 26–29, 1945, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

FIG. 1 CONVEYER AND MACHINE TOOLS IN CARBIDE-GRINDING DEPARTMENT

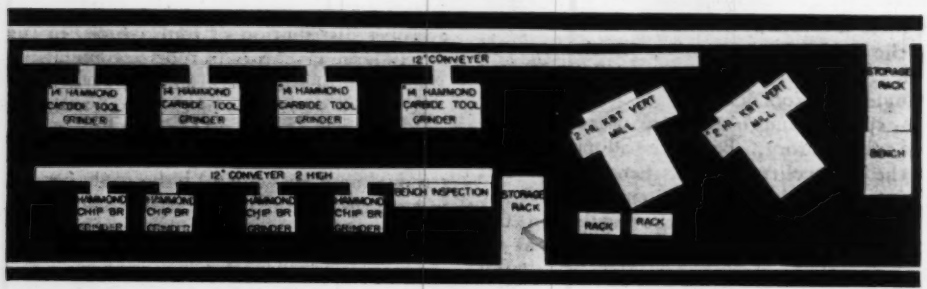


FIG. 2 ARRANGEMENT OF MACHINE TOOLS IN GRINDING DEPARTMENT

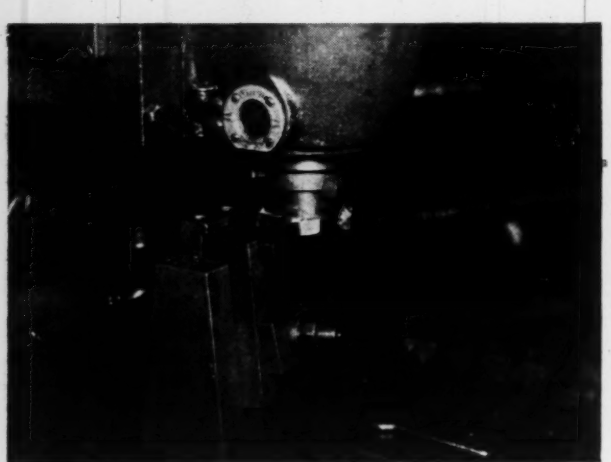


FIG. 3 MILLING SURPLUS STEEL ON NOSE OF TOOL, RIGHT- AND LEFT-HAND

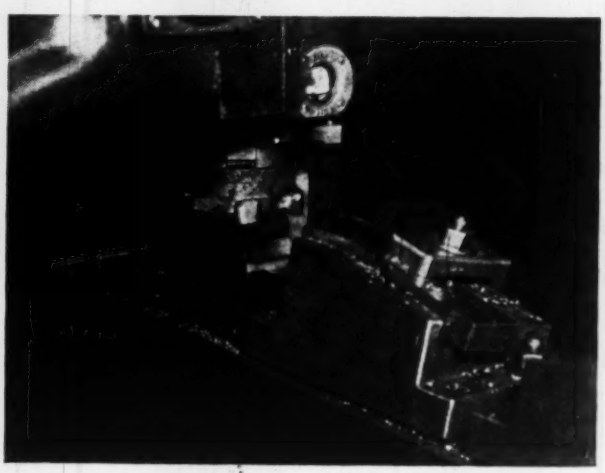


FIG. 4 MILLING SURPLUS STEEL ON SIDE OF TOOL, RIGHT- AND LEFT-HAND

The only record kept is a daily record sheet, which is posted by the sorter who records the following information:

(*a*) Tool usage by department and total by day.
(*b*) Number of worn-out tools.
(*c*) Number of broken tools.
(*d*) Number of resharpened tools.

From this record a check is maintained on the requirements of the various departments, and excessive breakage is easily spotted. These records are constantly referred to by the methods engineer in charge of carbides who uses the information for investigation of tool trouble.

HOW THE NEW SYSTEM FUNCTIONS

In laying out the grinding setup, it was decided to use a gravity-type roller conveyer to minimize the handling time

FIG. 5 ROUGH-GRIND NOSE OF TOOL

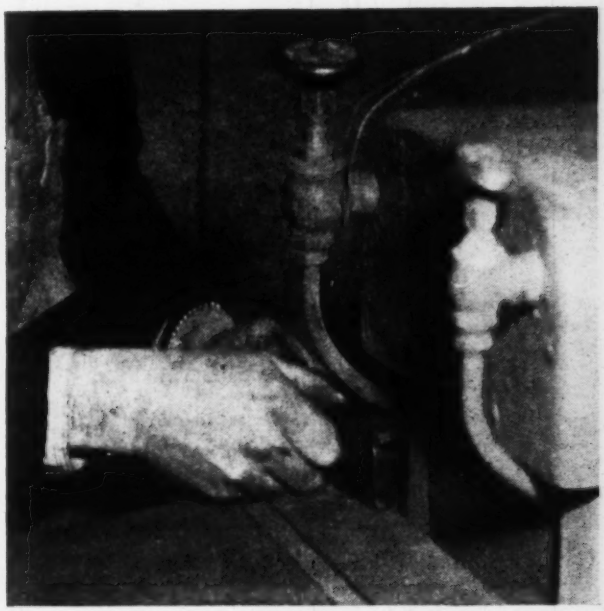


FIG. 6 ROUGH-GRIND SIDE OF TOOL

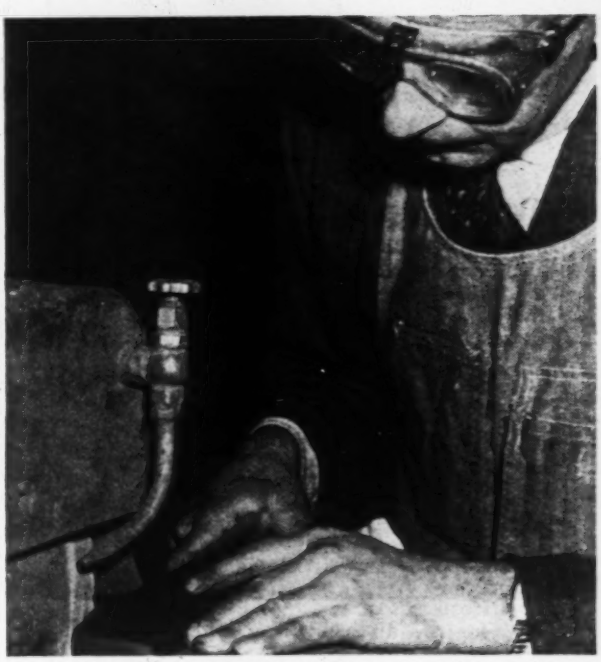


FIG. 7 GRINDING THE TOP OF THE TOOL

between operations, Fig. 1. Fig. 2 shows the arrangement of the machine tools in this department. The first two operations on the line are milling operations which are set up for the purpose of eliminating the snagging of steel from under the nose and side of those carbide tools having chipped tips, Figs. 3 and 4.

It is our experience that these two operations had to be performed on 25 per cent of the tools returned to cribs.

The machines used are No. 2 HL vertical milling machines with 4-in-diam, 6-tooth, negative-angle carbide mills running at 412 rpm with a feed of 6 ipm. It will be noted that in each operation the fixture is designed to hold left- and right-hand tools. The 12-deg clearance and 15-deg lead angles are incorporated in the fixtures.

The next two operations are performed on a No. 14 Hammond grinder with the table set at 10 deg for the clearance angle. Fig. 5 shows the operation of grinding the nose of the tool, while Fig. 6 shows the grinding of the side of the tool. Grinding the top of the carbide tip with the grinder table set at 90 deg with the wheel, is shown in Fig. 7. The abrasive wheel used in these three operations is a 14-in. × 4-in. × 11-in. cup, steel-back carborundum grade GC60-18-VW. The grinding

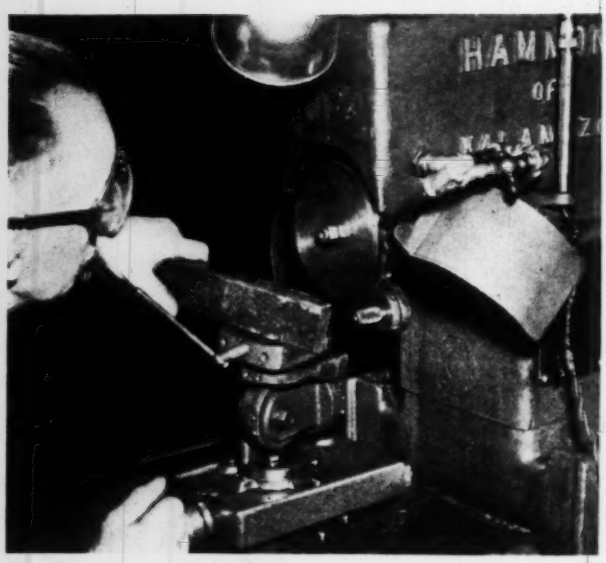


FIG. 8 GRINDING THE CHIP BREAKER

FIG. 9 DIAMOND-LAPPING 6-DEG CLEARANCE ANGLES ON NOSE AND SIDE OF TIP

FIG. 10 INSPECTION OF TOOLS

time for each of the three operations is one minute per operation.

After grinding the top of the carbide tip, the tools on the pallets are moved to the lower deck of the double-deck conveyer for the final diamond grinding operations. The operator grinding the chip breaker slides the pallet from the lower deck to his shelf and grinds the chip breaker, Fig. 8, using a 6-in. × 1/4-in. × 5/8-in. Norton D120-N100M-1/16-in. diamond wheel on a CB76 Hammond chip-breaker grinder. On the other side of the same machine the 6-deg primary clearance angles are lapped on the nose and side of the tip. For this operation a 6-in. × 3/4-in. × 1 1/4-in. × 3/4-in. rim Norton D120-N100M 1/32-in. diamond wheel is used. Upon the completion of the lapping operation, the tools are placed on their pallets on the top deck of the conveyer and are dispatched to the inspector at the end of the line, Fig. 10.

The inspector inspects the tools for proper finish, checks the angles with gages, and, under an inspectograph, checks for brazing and grinding cracks. After inspection the inspector places the ground tools in the finished-tool bin from which they are issued by the sorter to the tool cribs in exchange for the incoming tools.

This system has eliminated the tool-handling problems encountered in the previous system and has resulted in the machine operator's receiving a better tool. After the new system was installed, the total tools in circulation dropped to 3500 and the cost of the setup and rearrangement was rapidly written off.

LOCOMOTIVE TRENDS *on the* PENNSYLVANIA RAILROAD

By J. V. B. DUER

ASSISTANT TO VICE-PRESIDENT—OPERATION, THE PENNSYLVANIA RAILROAD

OVER a hundred years ago, two separate railroads, later to become a part of the Pennsylvania Railroad system, contributed some of the earliest and most interesting types of motive power in this country. It is the purpose of this paper to outline briefly the trend of locomotive design on the Pennsylvania Railroad which has taken place since that time, and then to present some conclusions as to future developments which it is believed will be self-evident.

LOCOMOTIVES OF THE 1830's

The two locomotives to which reference is made were the *John Bull*, built in England and sent to this country in 1831, for use on the Camden and Amboy Railroad, and the *Lancaster*, built by Matthias Baldwin in Philadelphia in 1834, and placed in service on the Philadelphia and Columbia Railroad, then a part of the main line of the Public Works system of the Commonwealth of Pennsylvania, a combination of railroads and canals extending from Philadelphia to Pittsburgh.

Both of these locomotives were alike in general characteristics, although quite different in detail. The *John Bull*, as originally built, had two pairs of drivers to which a leading truck was later added, while the *Lancaster* had one pair of drivers and a two-axle leading truck. Both locomotives were about the same general size and capacity, the *John Bull* weighing 24,400 lb, and the *Lancaster* 17,000 lb; the *John Bull*, however, having more total weight as well as more weight on the drivers, was of somewhat greater tractive effort than the *Lancaster*.

For the purposes of this discussion we may confine our comparison to the *Lancaster*, because this locomotive was followed by others of the same type which were considered generally satisfactory, hauling gross loads of 75 to 100 tons quite regularly, whereas the *John Bull*, as far as can be discovered, was never duplicated for use on the Pennsylvania Railroad, although it is permanently preserved in the National Museum in Washington as an example of the locomotives of its day.

LOCOMOTIVES OF THE 1850's

The author does not have a complete record of the changes in locomotive design which took place during the next 20 years, but during that time the Pennsylvania Railroad grew into a co-ordinated system and purchased or leased a number of important connecting lines. Until the end of the Civil War period the locomotives represented a great variety of designs with little possibility of standardization.

Two types, however, are representative of that period. The predominant freight locomotive was a ten-wheel type with a four-wheel leading truck and three pairs of drivers coupled with side rods. The locomotive *Aughwick*, built in 1855 by Baldwin is a typical example. It weighed 61,000 lb, of which 42,200 was on the drivers, and was designed especially for freight service.

An example of the passenger engine of this period on the Pennsylvania is the *John C. Breckenridge*, built by the Lancaster Locomotive Works in 1857 for the Philadelphia and Columbia Railroad, an "American" type, weighing 60,000 lb, of which 35,500 was on the drivers.

LOCOMOTIVE STANDARDIZATION ON THE PENNSYLVANIA

In 1860 the Pennsylvania began to standardize and simplify the design of its locomotives, and in 1868 complete drawings of a series of standard locomotives were prepared in Altoona, which was then developing into prominence as the principal manufacturing and repair-shop center of the railroad. Locomotives were built in the railroad company's own shops or by outside manufacturers over the standard plans of the railroad company's mechanical department.

The succeeding years until the close of the century saw many advances in design, bringing the locomotive nearer to the types we know today. The wood-burning locomotive disappeared from our railroad, and bituminous coal was generally adopted for fuel.

In 1869 the first tests of the air brake invented by George Westinghouse were made on the Pennsylvania. In 1870 it was adopted as standard on this railroad, and in 1878 the straight air brake was supplanted by the automatic air brake.

LOCOMOTIVES OF THE 1890's

By 1890 the "American" type locomotive was the standard for passenger service and had increased considerably in size over the *John C. Breckenridge*, built in 1857. The type in service in 1895 was the railroad classification D-16, having a total weight of 135,300 lb, of which 93,600 was on the drivers, quite a substantial increase over the early type, as represented by the *John C. Breckenridge*, the weight on the drivers having increased nearly 3 times, and the total $2^1/_2$ times.

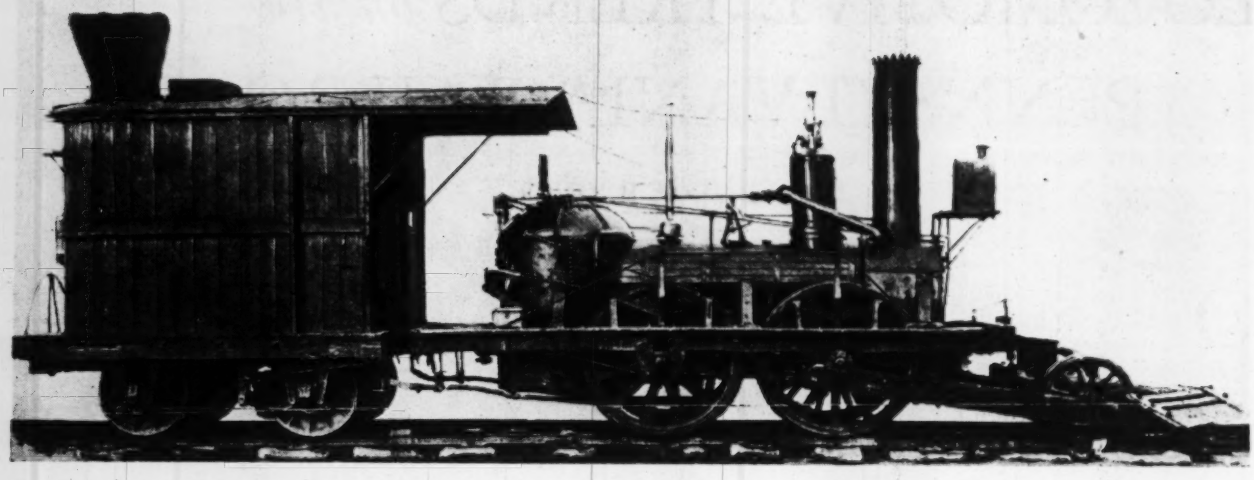
During this same period the freight locomotive had developed into what was known as the "Consolidation" type, a locomotive having a single guiding axle and four pairs of drivers. On the Pennsylvania these locomotives were known by the railroad classification of "H", and the H-3b engine which was placed in service in 1891, was representative, having a total weight of 127,000 lb, of which 115,000 was on the drivers.

This again showed a substantial increase over its *Aughwick* progenitor of 1855, the total weight being over twice as much, and the weight on drivers almost 3 times as much, a substantial advance in 38 years.

LOCOMOTIVES OF THE EARLY TWENTIETH CENTURY

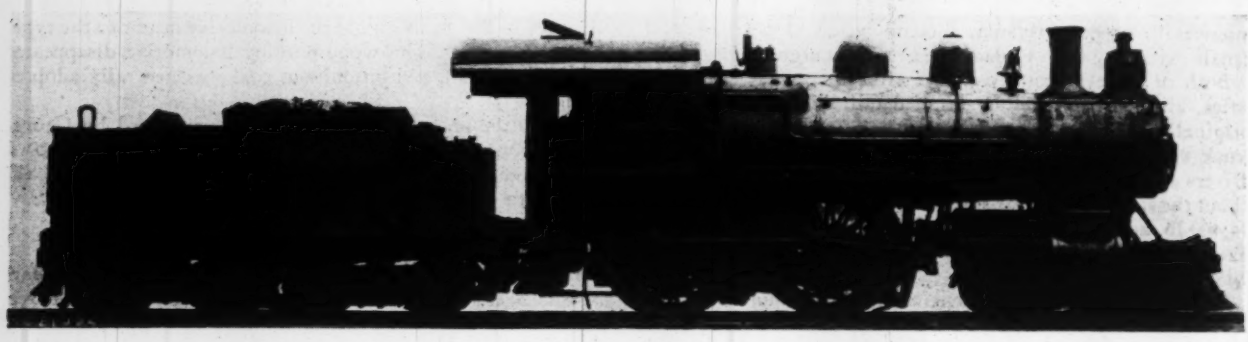
During the 20 years from 1895 to 1915 locomotive development on the Pennsylvania took a rather decided step forward. In 1904 a locomotive test plant, which had been a part of the Pennsylvania exhibit at the Louisiana Purchase Exposition, was added to the test department equipment at Altoona, thus per-

Contributed by the Railroad Division, and presented at the Annual Meeting, New York, N. Y., November 26–29, 1945, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.



THE JOHN BULL, BUILT IN ENGLAND AND OPERATED ON THE CAMDEN AND AMBOY RAILROAD

Date built	1831
Total weight of engine	24400 lb
Total length of engine and tender	36 ft $3^1/_2$ in.
Height over-all	12 ft 11 in.
Width over-all	8 ft 6 in.
Operating speed	15 to 20 mph



"AMERICAN" TYPE PASSENGER LOCOMOTIVE OF 1895, RAILROAD CLASSIFICATION "D-16"

Classification	D-16
Service	Passenger
Date built	1895
Weight on drivers	93600 lb
Starting drawbar pull	19367 lb
Total length of engine and tender	60 ft $3^5/_8$ in.
Height over-all	15 ft 0 in.
Width over-all	9 ft 8 in.

mitting complete tests of locomotives under conditions closely approximating those of actual operation.

The results proved of great value and materially influenced the course of motive-power development on the Pennsylvania.

By 1911 all Pennsylvania locomotives were being equipped for the use of superheated steam, and by 1913 this had been made a standard for all new locomotives built for the system and proved to be a major improvement, helping to increase the tractive effort at speeds needed to handle the heavier cars, made of steel, which the Pennsylvania was then placing in its passenger service. The first of these cars was placed in service in 1906, and extended use of this equipment was hastened in 1907 because of the approaching completion of the New York tunnels and Pennsylvania Station, through which the railroad had determined that it would run only steel cars.

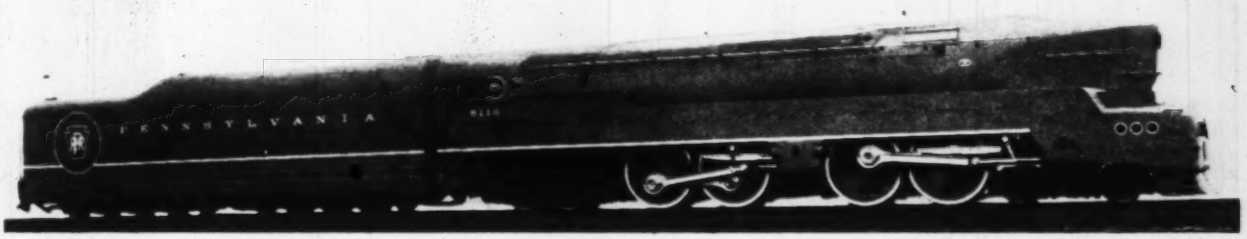
The standard passenger locomotives in service on the railroad in 1915, were the "E" or "Atlantic" type locomotives, the "K" or "Pacific" type locomotives, and the larger "Consolidation" or "H" type locomotive, as well as the "Mikado" or "L" type in freight service.

Both the "E" and the "K" type locomotives had been developed because of the increasing importance in high-speed passenger service of a larger firebox to give the locomotive high capacity at high speed, and this in turn had caused the introduction of trailing wheels behind the drivers and under the firebox to permit of the additional room required for the furnace capacity necessary in high-speed operation.

The most modern "E" locomotive in service in 1915 was known as the "E-6s," having a total weight of 243,600 lb, of which 136,000 was on the drivers. The "Pacific" type was of the "K-4s" classification, having a weight of 308,890 lb, of which 201,830 was on the drivers.

"PACIFIC" TYPE LOCOMOTIVE OF THE K-4S CLASS, FOR HIGH-SPEED PASSENGER SERVICE

Classification	K-4s
Service	Passenger
Date built	1914
Weight on drivers	201830 lb
Starting drawbar pull	44460 lb
Maximum continuous drawbar horsepower	2715 hp
Speed at maximum continuous horsepower	42 mph
Drawbar pull at maximum continuous horsepower	22610 lb
Total length of engine and tender	80 ft 5 1/2 in.
Height over-all	15 ft 0 in.
Width over-all	10 ft. 7 in.



STREAMLINED "T-1" CLASS LOCOMOTIVE FOR PASSENGER SERVICE, WHICH IS FITTED WITH POPPET VALVES

Classification	T-1
Service	Passenger
Date built	1942
Weight on drivers	268200 lb
Starting drawbar pull	64650 lb
Maximum continuous drawbar horsepower	5408 hp
Speed at maximum continuous horsepower	60 mph
Drawbar pull at maximum continuous horsepower	33800 lb
Total length of engine and tender	122 ft 9 3/4 in.
Height over-all	15 ft 6 in.
Width over-all	10 ft 7 in.

The freight engines in service were the "H-9s," "H-10s" and "L-1s" types, the "H" engines having approximately 250,000 lb total weight of which 223,000 was on the drivers, and the "L" engines weighing 320,700 lb, of which 240,200 was on the drivers. The "H" engines were used in slow freight service and the "L" engines in fast freight service, the latter having the same arrangement of trailing wheels to permit of enlarged firebox capacity as was true of the passenger engines.

ELECTRIC LOCOMOTIVES

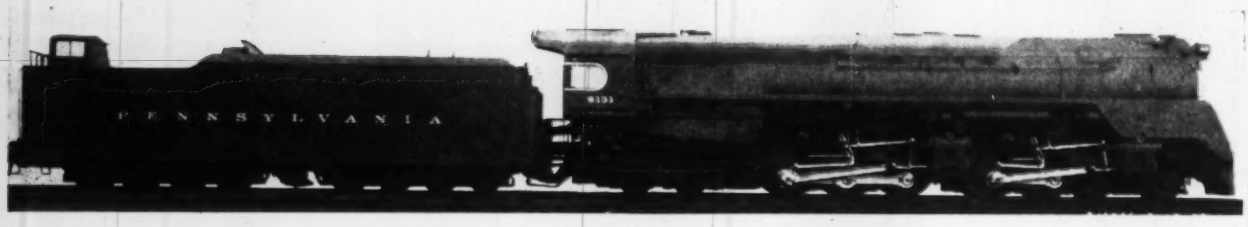
In 1910 the Pennsylvania Railroad opened its tunnels to New York and its Pennsylvania Station in that city. About 1905 a series of tests and engineering designs had been made to develop an electric-locomotive type suitable for this important terminal.

These designs and tests finally culminated in the so-called "DD-1" electric locomotive, which was essentially two "American" type locomotives coupled back to back, having a total weight of 313,000 lb, of which 199,000 was on the drivers. These locomotives remained in this service until the railroad was electrified to Philadelphia, at which time the single-phase alternating-current type locomotives replaced them.

LOCOMOTIVES OF 1935

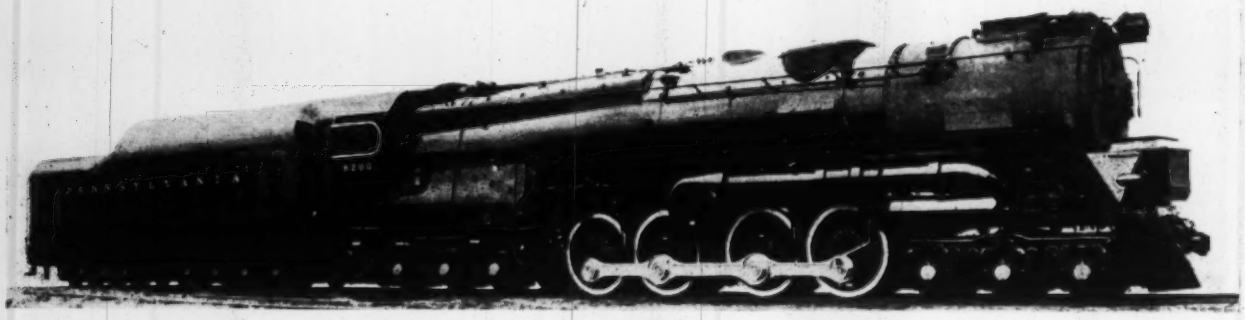
During the period from 1915 to 1935 locomotive advances on the Pennsylvania consisted in both steam and electric development. The "Mountain" type, or "M-1" steam locomotive was introduced in 1923, for high-speed passenger and freight service; this locomotive weighing 385,000 lb, of which 267,000 was on the drivers, was the first steam locomotive built on the Pennsylvania for many years which was adaptable for both passenger and freight service. Also during this time, the "I-1s" had been built and placed in service in 1916 in large quantities, this being a "Decapod" type having a total weight of 371,000 lb of which 341,000 was on the drivers. The "I-1s" was peculiarly well adapted for slow freight service, while the "M-1" supplemented it to good advantage for fast freight and passenger service.

In 1928 the railroad management decided to electrify the road between New York and Washington, and New York and Harrisburg, and several high-capacity electric-locomotive types were constructed and tested. These tests finally culminated in the selection of two types of locomotives: one the "P-5", a 4-6-4 locomotive having a total weight of 392 000 lb, of which



HIGH-CAPACITY FREIGHT LOCOMOTIVE "Q-2" OF THE FOUR-CYLINDER TYPE

Classification	Q-2
Service	Freight
Date built	1944
Weight on drivers	393000 lb
Starting drawbar pull	100800 lb
Starting drawbar pull with booster	115800 lb
Maximum continuous drawbar horsepower	6645 hp
Speed at maximum continuous horsepower	35 mph
Drawbar pull at maximum continuous horsepower	71200 lb
Total length of engine and tender	124 ft 7 1/8 in.
Height over-all	16 ft 5 1/2 in.
Width over-all	11 ft 0 in.



THE "S-2" LOCOMOTIVE FEATURING GEARED-TURBINE DRIVE

Classification	S-2
Service	Freight and passenger
Date built	1944
Weight on drivers	260000 lb
Starting drawbar pull	65000 lb
Maximum continuous drawbar horsepower	5792 hp
Speed at maximum continuous horsepower	60 mph
Drawbar pull at maximum continuous horsepower	36200 lb
Total length of engine and tender	122 ft 7 1/4 in.
Height over-all	16 ft 0 in.
Width over-all	10 ft 6 in.

220,000 is on the drivers, and the "GG-1", a 4-6-0+0-6-4 locomotive of the articulated type, having a total weight of 475,000 lb, of which 303,000 is on the drivers.

The "GG-1" showed marked superiority for high-speed passenger service both as to capacity and tracking characteristics, and the "P-5" locomotives were therefore assigned to freight service and the "GG-1's" to passenger service.

CHANGES IN ROADWAY AND STRUCTURES

During the hundred-year period in which the locomotive development briefly outlined was occurring, great changes had taken place in the railroad on which these locomotives operated.

Roadway development had kept pace with this motive-power improvement; the roadbed had been improved with better ballast, better ties and better drainage, the rails had been made heavier, the bridges and structures strengthened to handle the increasing train weights, and a balanced development of railroad facilities had taken place through the addition of more modern terminals with better facilities for taking care of the traveling public. The introduction of larger motive power and better roadbed produced improved schedules and all departments of the railroad co-operated in producing a better transportation tool for the use of the public.

MODERN MOTIVE POWER

After electrification of the Pennsylvania eastern lines was completed, attention was concentrated by the management on the development of still more modern motive-power units. In 1937 the railroad requested three locomotive builders, American Locomotive, Baldwin, and Lima, to co-operate with the railroad engineers in the design of a high-speed high-capacity passenger locomotive, and this invitation was unanimously accepted, resulting in the design of the "S-1" locomotive, a four-cylinder type which was exhibited at the World's Fair in 1939.

As a result of this development the Baldwin Locomotive Works proceeded with the design of a similar locomotive of slightly smaller dimensions, incorporating poppet valves, which they submitted to the railroad in 1940, and of which the railroad purchased and placed in service two units. These loco-

(*Continued on page 452*)

MATERIALS *of* CONSTRUCTION *in the* PETROLEUM INDUSTRY

By T. McLEAN JASPER

DIRECTOR OF RESEARCH, GENERAL AMERICAN TRANSPORTATION CORPORATION, CHICAGO, ILL. MEMBER A.S.M.E.

THE recent emergency increased materially the items of commerce and engineering produced by and for the petroleum industry. Many of the new items will work just as well for peace as for war, and therefore we may look forward to the retention of advancements which have been made. The use of materials in this industry calls for considerable knowledge of their characteristics so that the principles of economic engineering may be satisfied in their use. What is implied by economic engineering involves the selection of materials so that their application will produce the resultant structure for the least total cost in the service to be undertaken, considering the safety of operations and the life of the plant. The engineer, the metallurgist, the fabricator, and the operator involved in this work must co-operate fully to attain the desired result.

PRODUCTION OF OIL WELLS

The producer of oil wells for the petroleum industry will in the future be required to drill to greater depths. This requires qualities in the engineering materials of increased strength and resistance to abrasion, fatigue, and corrosion. It is fortunate that not all of these qualities need be combined for all of the engineering materials used in production. It does, however, imply that good technical knowledge should be applied in the proper selection and application of such materials.

The alloying elements in steel that will increase strength most economically are manganese and carbon. In casing, where it is necessary to increase resistance against collapse, the least expensive method is cold compression of the tubes in the transverse direction. Whatever may increase the compressive yield strength of steel will also perform the same function for thick pipe. For resistance to abrasion, the most important alloying materials for drilling operations are manganese, molybdenum, and tungsten. A proper combination with carbon is important in this connection also.

General resistance to abrasion should be mentioned. It is believed that many engineers and some metallurgists think of abrasion resistance as being somewhat synonymous with hardness. This depends very largely on whether the abrasion to be resisted is light, medium, or heavy, and whether the material to be detached or resisted is soft, hard, or tough. The hardness of glass, for instance, coupled with its general fragility, makes it in most instances a poor tool to use to resist abrasion. However, the diamond properly attached to a tool is a most useful medium for certain conditions of cutting or drilling. Both are hard, one is tough, the other is brittle or fragile.

Abrasion resistance requires a combination of properties involving toughness, resilience, surface hardness for some problems, or a combination of one or more of these properties in order to produce the best results.

The classical example of abrasion resistance is that a good rubber tire of a given thickness can last to carry more ton-miles of transportation on a concrete road than can an ordinary steel tire of the same thickness in terms of ton-miles of the same type of transportation.

To increase the endurance limit or resistance to fatigue, nearly any method which increases the ultimate strength of steel will perform this function. For resistance to corrosion in steel at production temperatures, chromium and/or nickel are the most direct and successful alloying elements for the type of service associated with the production of petroleum from the ground. To perform the desired functions most economically, requires experience as to which one or more, if any, of the alloying materials should be used and how much.

TRANSPORTATION AND STORAGE

Materials for building and maintaining the system for the transportation and storage of petroleum gases and liquids, and the by-products obtained from the refining of such gases and liquids, can become a problem which will tax the technical ingenuity of the petroleum industry. Crude oils are transported in tankers, inland barges, pipe lines, and tank cars. Gases, except those which can most easily be liquefied, are transported in pipe lines. These oils are not highly corrosive in general and therefore plain steel containers are the rule. Where corrosion becomes a problem in connection with the transportation of crude products it is generally from the outside of the container and results from weathering or soil contact. To resist this type of corrosion steel is one of the most expensive materials. Where the corrosion problem becomes important, as in particular types of soil corrosion, a coating of tar or asphalt wrapped in fabric is used for pipe coating and becomes much more economical than alloying or thickening the steel. Recent developments indicate that some of the plastic coatings may fit into this situation as they become better understood and less expensive. Cathodic protection is also used in some localities; this depends on the soil conditions found and the experience of the operator of the pipe lines. When and where to apply aids to resist corrosion is a matter of experience and knowledge. What applies to transportation facilities applies generally to storage facilities for crude products.

Transportation of the by-products of refining can sometimes result in exceedingly difficult problems of corrosion. The ordinary steel tank car, pipe line, tanker, inland barge, or storage tank is sufficient for many of the common motor fuels when unprotected internally. As the synthetic products of refining become increasingly available, the question of combating corrosion of the container and the deterioration of the product becomes more important. Lubricating oil and high-octane gasoline should be absolutely free from fine particles of iron oxide.

To an even greater extent the refinery is becoming a chemical plant with all of the problems of such a plant. Solvents, as well as other products used for plastics which must have no iron contaminations, require in some instances that we use aluminum for the tank which is built into the tank car and the storage facility.

Contributed by the Petroleum Division and presented at the Annual Meeting, New York, N. Y., Nov. 26–29, 1945, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The engineer who applies the economic engineering principle to his problem of transportation and storage thinks, under certain circumstances, of teaming steel for strength with other materials for corrosion resistance, bearing in mind that steel is the most economical material that can be employed for carrying heavy loads. On the other hand, it is one of the most expensive materials when corrosion is a major consideration, particularly at normal atmospheric temperatures.

Many and varied items which aid in corrosion resistance have been given an opportunity to demonstrate their value in transportation and storage of petroleum and the products manufactured from it during the recent emergency. These will now have the opportunity to prove and establish the proper place which they are to occupy in the more stabilized future which we are fast approaching.

MATERIALS FOR REFINING PROCESSES

The application of materials to the problems of refining calls for a greater knowledge of materials selection than that associated with production or transportation. Refining involves high-temperature and high-pressure operations. Many refining processes are also associated with low-temperature operations, and these tend to reduce the working pressures at which the low temperatures are effective. In conjunction with both the high-temperature and low-temperature operations, conditions may exist of differential cyclic stresses which become of considerable importance when the temperature changes are rapid. Then the conditions of operation involve heavy sections of material. Little is known about fatigue at high or low temperatures except that, at high temperatures the values are reduced, and at low temperatures the values are increased but the materials have a greater tendency toward brittleness.

Chemical activity increases rapidly as temperatures of operation are increased. On the other hand, strength of materials decreases rapidly at the higher temperatures of refining. Metal temperatures of 1200 F, and a container pressure of 3000 psi are encountered in oil-refining processes. Ceramic-material temperatures may reach much higher values than that mentioned. The desired chemical reactions, however, are more rapid and more complete at the higher temperatures of operation; so much so that economic engineering sometimes calls for very expensive materials because of their greatly enhanced resistance to the conditions of refining.

The alloying materials most suited to improving the strength of steel at elevated temperatures are chromium, molybdenum, and nickel. Often associated with these are vanadium, columbium, or titanium. For pressure-vessel steel, tungsten is not used because of its cost and the trouble encountered in forming steel containing it. However, tungsten is used with nickel and molybdenum, or chromium with nickel may also be used in high-strength bolts for high-temperature service.

The alloying materials most suited to improve the ductility and shock resistance of steel at low temperatures are nickel, manganese, and silicon. There is no doubt but that a clean well-deoxidized steel gives the best results. For intermediate low temperatures, manganese and silicon, properly balanced, can meet the general specifications called for.

The alloying materials most suited to enhance the corrosion resistance to high-temperature refinery operations are chromium and nickel. Along with these, small amounts of titanium or columbium are used in many instances to render the steel more satisfactory.

In steel, chromium and its appropriate associate alloys seem to do best where resistance to high-temperature corrosion is important, and where sulphur is the corroding medium. Nickel and its appropriate associate alloys occupy the position of being most helpful in low-temperature service where chloride is the factor which produces corrosion.

It should be clearly understood that special alloying of metals is not the only method that the refiner of petroleum uses to combat corrosion. The introduction of neutralizing chemical agents is also used where the results show them to be the most economical.

Since the most economical steel for load carrying is not necessarily the same as that required for corrosion resistance, the economic engineering point of view calls, in many instances, for an inner lining of more expensive corrosion-resistant material and an outer and thicker layer of higher-strength load-carrying material. On the other hand, for thin-walled vessels where corrosion resistance is of importance, a solid corrosion-resistant metal is the most economical. As the pressure of operation increases, the thickness increases and a dual metal offers the most appropriate selection. Clad materials (the so-called ply metals), spot-welded liners, plug-welded liners, and inner layers of corrosion-resistant metals are all used.

A considerable amount of ceramic materials of various kinds are used in the refining operations. Such materials are used on the inside of vessels in some processes to insulate the outer steel from the high temperatures of the operation; and sometimes to resist the corrosive attack of the petroleum materials being processed. In this manner, a reduction in steel wall thickness can be made. Such liners, of course, also have the effect of reducing heat losses to the outside of vessels.

The proper selection of materials is a problem of the designer, fabricator, and operator who must work in close collaboration if the best results are to be achieved.

OPERATION OF REFINERY EQUIPMENT

For many of the functions in a refinery, the use of materials follows the demands for transportation and storage. The author will not attempt to discuss valve, pump, compressor, and power operation in the oil industry. However, he has been called in on several of the troubles associated with such operations. It might be said that the operation of refinery equipment sometimes involves large temperature differential stresses. In many cases these stresses have not been considered in the designs. It should be pointed out here that temperature stresses due to rapid cooling are sometimes responsible for operating failures of important structures. These failures can be reduced, and the hazard of failure practically eliminated, if attention is paid to cooling rates, and to a reduction of the thickness of the materials to be cooled.

The author's experience indicates that a vessel 4 in. thick is at least 6 times as hazardous as a vessel 2 in. thick when too rapid cooling is practiced, provided both vessels are designed with the same operating factor of safety. In one instance the operating temperature of certain vessels was 900 F. Quick cooling of such vessels, in bringing them out of service for cleaning out the coke, was responsible for stress differentials which could, and did, cause vessel failure. This fact led to the selection of steel with a greater long-time strength at 900 F, resulting in reduction of the needed thickness from 4 in. to 2 in. for the same vessel size. It should be apparent, therefore, that there are factors in the use of materials where in many cases the increase of plate thickness decreases the safety of such equipment. There are undoubtedly many other methods of reducing temperature stress differentials with which the author is not familiar.

FAILURE OF REFINERY VESSELS

It might be appropriate to digress here to give a brief discussion of the reasons for cooling stress failures. Such failures in

(*Continued on page 431*)

Postwar WOOD FINISHES *and Specialized* WOOD TREATMENT

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BASED upon recent developments and as a natural outgrowth of the accelerated pace of technical advancement in the past several years, it is quite reasonable to look for improvement in the field of wood finishing. Such progress will be evident in both physical improvement of film structures and in economic values gained from better methods of application.

A recent survey of the finishing department of a large manufacturer of furniture produced indisputable evidence that the type materials and methods of finishing used in prewar applications could easily be altered to produce superior coatings, as well as to show a substantial reduction in the cost of the application. Obviously, such improvements will be reflected in increased sales volumes at lower per unit costs.

The following factors are worthy of brief attention in considering the physical and mechanical improvements in wood-finishing materials: (1) mar resistance, (2) chemical resistance, (3) improved clarity and depth, (4) improved preservation of the wood, (5) longer film life, or durability.

Each one of the foregoing factors is a sufficiently broad subject to merit a paper in its own right. We may only indicate that the technical advances noted in the past few years make each and every one of those factors of extreme importance to every member of those industries dealing with wood products.

ECONOMIC IMPROVEMENTS IN WOOD FINISHES

In the field of economic improvements the following possibilities are evident:

1 Lower costs per volume unit of finishing material which may be applied, due to higher solids concentration.

2 Savings in time, labor, and storage space due to improved drying schedules.

3 Savings in time and labor through the elimination of multiple-coat finishes.

4 Savings developed from the use of new types of equipment and methods of application.

Achieving these improvements and advantages has been attained through the investigation and the utilization of the following basic types of raw material. That continuing progress may be expected through the constant application of research technology is sufficiently obvious to make further discussion unnecessary.

1 Melamine finishes.
2 Melamine-urea-formaldehyde finishes.
3 Vinyl coatings.
4 Styrene coatings.
5 Acrylic coatings.
6 Polyamide finishes.
7 Improvements in previous systems such as phenolics, alkyds, etc.
8 The use of varying viscosities and newer-typ ecellulose esters, e.g., acetate, butyrate, etc.
9 The utilization of the new-type low-pressure laminates, or contact resins.

Once again it must be mentioned that the opportunities for improvements through the utilization of the factors mentioned is almost unlimited. Only through a careful analysis of the needs of any given manufacturing process, in order to relate the ensuing product to the largest and most profitable market, can an intelligent application of these new developments be utilized. To those who are willing to apply objective research technology to their specific problems will come preferred positions in the competitive market. There is a vast amount of work yet to be done. On the other hand, a vaster amount of work has already been completed. What lies ahead is the adaptation of these new materials and methods to the individual manufacturing process.

ARMY EQUIPMENT REQUIRES SPECIALIZED WOOD TREATMENT

In discussing the subject of specialized wood treatment, it seems advisable to undertake a brief treatment of recent developments in this field.

During the past two years, because of the emergency created by the war both in Europe and Japan, a great deal of work has been done by the Armed Services and private industry, in treating wood products to withstand the severe exposure conditions that stored equipment encountered in various parts of the world.

A short description of what type of conditions is experienced would help visualize the general problem. For example, it is known that Ground Signal Corps equipment undergoes more severe storage and operational exposure than any other equipment in all the services. Let us use this as a representative service and describe the type of exposures encountered by materials used in ground signal operations.

There are two types of exposure to which wood of all types and wood-finishing systems are exposed: (*a*) Outdoor exposure; (*b*) indoor exposure.

Outdoor exposure is generally defined as tropical, jungle, arctic, or desert conditions which include but are not limited to any possible combinations of the following:

1 Ambient temperatures ranging from —40 F to 150 F with rapid fluctuations within that range.
2 Relative humidities up to 100 per cent.
3 Dust and sand storms.
4 Hail and rain.
5 Salt-laden spray.
6 Direct rays of the sun.
7 Biological flora: (*a*) Fungi and bacteria of the types encountered on land and in marine localities. (*b*) Animal life as encountered on land and in, or on, the sea. Example: insects and barnacles.

Indoor exposure covers finishes sheltered from the elements.

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Such finishes may encounter any combination of the following conditions:

1 Ambient temperatures ranging from —40 F to 150 F with rapid fluctuations within that range.

2 Relative humidities up to 100 per cent.

3 Salt-laden spray.

4 Biological flora: (*a*) Fungi and bacteria encountered on land and in marine localities. (*b*) Animal life such as insects.

The foregoing illustrate briefly the types of conditions that wood products or wood finishes will encounter if used on any equipment procured by the Army Service Forces. Now the question arises, "How can we prevent any degradation or deleterious effects to wood products under such drastic conditions?" Currently, the Signal Corps advocates that any wood, whether it is untreated wood or plywood, should be basically treated with a wood sealer of the Class 638 in accordance with the Army Ordnance Specification T.A.C. E.S.—#680.

Under the Class 638 wood-sealer specification it is required that this material be a solution which is pigment-free, and contain 16 per cent water-repellent solids at time of application. The material used is generally one of two types which are based on the rate of drying. Type 1 is required to dry in 1 hr and contains alkyds only. Type 2 is required to dry in 18 hr and contains treated oils free of rosin and rosin derivatives.

The various fungicidal ingredients are as follows: 0.02 per cent based upon weight of solids of phenyl mercuric oleate, or 5 per cent based upon weight of solids of chlorinated phenols consisting of pentachloro phenol between 80 per cent and 100 per cent, chloro-ortho phenol, 0-40 per cent, and tetra chloro phenol, 0-30 per cent.

There are, however, other methods of treating wood in so far as the wood sealer is concerned in order to preserve it against the drastic elements and conditions. These methods, which have been approved by the Signal Corps, are as follows:

1 To use impregnating salts under pressure on wood as a substitute for the wood sealer.

2 To use a creosote blend as an impregnant on wood as a preservative.

3 To use a hot-oil blend with 15 per cent pentachloro phenol at 160 F as an impregnant on wood, with an immediate cold-oil immersion application.

All these methods are currently in use by the services in treating wood products.

However, since Ground Signal Corps requirements are not in general the requirements of the other services, for illustrative purposes, note the conditions necessary in a wood sealer required by barges with wooden surfaces above the water line. The wood sealer used in this instance is governed by the Army Ordnance Specification AXS-1076 and contains the following: Phthalic anhydride, 30 to 40 per cent; pigment, not under 5 per cent; pine oil, 10 per cent.

The toxicants used in pentachloro phenol are in a concentration of 15 per cent based on weight of solids. This material is generally thinned with two volumes of petroleum spirits before application.

The treatments just discussed pertain to both untreated wood and plywood. In the case of plywood, another factor is encountered which may cause biological deterioration and loss in general tensile strength of the wood material. It is recommended that all plywood be cemented in accordance with Army-Navy Specification ANG-8 which calls for synthetic-resin cement. However, there are many instances noted where the use of animal- or vegetable-origin glues still prevail. These glues will definitely deteriorate under the drastic conditions of the services. If the origin is of an animal or vegetable nature, and is still considered moisture-resistant, it must be preserved by means of a toxicant which may be either the phenyl-mercuric series or the chlorinated phenols. However, if it is of hydrolized vegetable origin, it will not meet the extreme moisture requirement of the service since it would be too soluble in water.

Portions or all of the data with reference to specialized treatment for the preservation of wood products are for the most part matters of common interest and knowledge. They serve only to point the way to new standards in manufacturing processes as applied to civilian products.

PUBLIC-HEALTH ASPECT OF DEVELOPMENTS IN FINISHES

The question of deterioration of wood products through the deleterious effects created by biological flora, including fungi and bacteria, as well as microorganic structures deserves a great deal of consideration. In the past we have all accepted normal durability factors (where style plays a minor part) with relatively little questioning and considerable complacence. In the future the ability to preserve plywood laminates for indefinite periods of time may have an unusual effect upon the types of engineering design and manufacturing processes employed.

Furthermore, the very real possibility that it is possible, though not as yet practical, to produce fungistatic and bacteriastatic finishes to be applied on all types of surfaces will quite probably have an unusual effect upon our conception of public-health laws. Can one visualize the possible improvements in the health of a nation where every paintable surface was so formulated as to prevent the growth of infectious fungi and bacteria? Such a conception has already been termed a wild dream, and yet starting from scratch a few years ago, great progress is now evident concerning just such a medium to be utilized in any type coating.

Applied research is now under way at the Centro Research Laboratories in co-operation with several clients in the field of coating materials to produce fungistatic and bacteriastatic finishes for hospitals, schools, theaters, and various other types of public buildings. These are the preliminary and most important mediums through which such coatings may help to lower the rate of spread of at least a few infectious diseases. With the surface barely scratched, there has already been compiled an enormous amount of technical data, most of which will have a bearing in every other field needing such protective devices. It is certainly apparent that the treatment of wood products and the development of wood finishes must inevitably become a part of this broad program. Who can say what the final values might be? If the incidence of infection is lowered by as little as 5 per cent, the contribution to the welfare of the nation will be well worth the time, effort, and expense.

CO-OPERATIVE EFFORT REQUIRED

The whole problem is not so much a matter of research, but rather a crying need to secure the co-operation of the many organizations, official, political, and industrial, to speed a basic program on its way to an inevitable conclusion. While much remains to be accomplished in the laboratory, the broad outlines of knowledge have been attained and proved. As with almost every revolutionary process in the realm of science, the highest hurdles to be conquered are obstructions and difficulties created by our complacency with past performances.

Fungistatic finishes are already a fact. Bacteriastatic finishes are just ahead. Their applications to innumerable surfaces to help in building a better place in which to live is simply a matter of time.

Research pioneered the destructive path of the atomic bomb. Research will always build constructively in a world at peace. The wood industries will play a large part in a better postwar world. Not the least significant contribution to be made will come through an appreciation and understanding of postwar wood finishes and treatments.

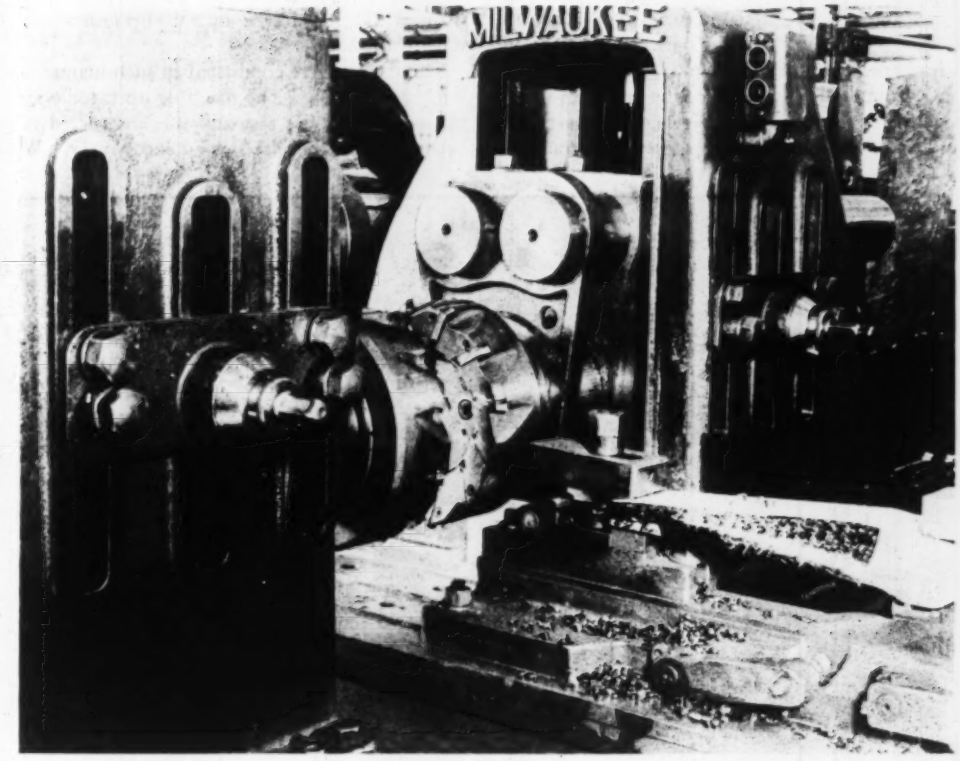

FIG. 1 ROUGHING OPERATION ON A WING HINGE, S.A.E. 4340 STEEL, BHN 200
(The cutter has solid cemented-carbide blades located in the body of the milling cutter at a 15-deg positive radial rake angle.)

Data on PRODUCTION RUNS *with* CARBIDE MILLING CUTTERS

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THE tests reported in this paper were performed on a production machine handled by the regular operator using run-of-the-lot production workpieces. Comparison data concerning three types of cutters were gathered during this investigation.

Studies of radial rake angles in face milling, conducted by the author's company, have resulted in the development of an improved type of face-milling cutter.[1] In numerous laboratory tests this cutter has shown characteristics superior to those in general usage. It was to check the efficiency of this kind of cutter in shopwork that this comparison with two types of cutters of commonly accepted design was instituted.

J. B. Armitage and the author have presented several papers pointing out the advantages of combining the increased strength afforded by negative radial rake angles with the lower power requirement of positive radial rake angles.[2] The chief characteristic of a milling cutter, designed in accordance with this principle, is the location of a solid carbide blade wedged into the cutter body at a positive secondary radial rake angle with a negative primary radial rake angle imposed at the peripheral cutting edge. Although the superiority of this cutter design had been verified in laboratory tests, it was felt necessary to prove its practicability in production operations in direct comparison with cutters of different design.

TYPICAL APPLICATION

A duplex face-milling operation set up as shown in Fig. 1, was selected as a typical application employing carbide-tipped face-milling cutters. The workpiece, an aircraft wing-hinge forging of S.A.E. 4340 steel normalized to 200 Bhn, was milled

[1] "An Investigation of Radial Rake Angles in Face Milling," by J. B. Armitage and A. O. Schmidt, Trans. A.S.M.E., vol. 66, 1944, pp. 633–643; also *Western Metals*, July, 1945, pp. 11–16, and Aug., 1945, pp. 9–13.

Contributed by the Research Committee on Metal Cutting Data and Bibliography and presented at the Fall Meeting, Cincinnati, Ohio, Oct. 2–3, 1945, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[2] "Radial Rake Angles in Face Milling," by J. B. Armitage and A. O. Schmidt, MECHANICAL ENGINEERING, vol. 67, 1945, pp. 403–406; vol. 67, 1945, pp. 453–456; vol. 67, 1945, pp. 507–510. *Canadian Machinery and Manfacturing News*, vol. 46, no. 9, 1945, pp. 114–116; no. 10 1945, pp. 81–84; no. 11, 1945, pp. 90–93.

as shown in Figs. 5 and 6. The first cut was approximately $3^1/_2$ in. long, $2^5/_8$ in. wide, and $^1/_8$ to $^{13}/_{32}$ in. deep, while the second cut was approximately 10 in. long, $1^1/_2$ in. wide, and $^1/_8$ to $^5/_{16}$ in. deep. Comparative tests were run on pieces in the same lot to avoid, wherever possible, differences in the workpiece material and size. Both cuts were performed on a Milwaukee Duplex driven by a 10-hp motor, standard equipment with the machine.

These tests were conducted in such manner as not to interfere with production. The machine operator was acquainted with the purpose of the test and was instructed to remove a set of cutters before they had worn excessively. Wear of $^1/_{32}$ in. on

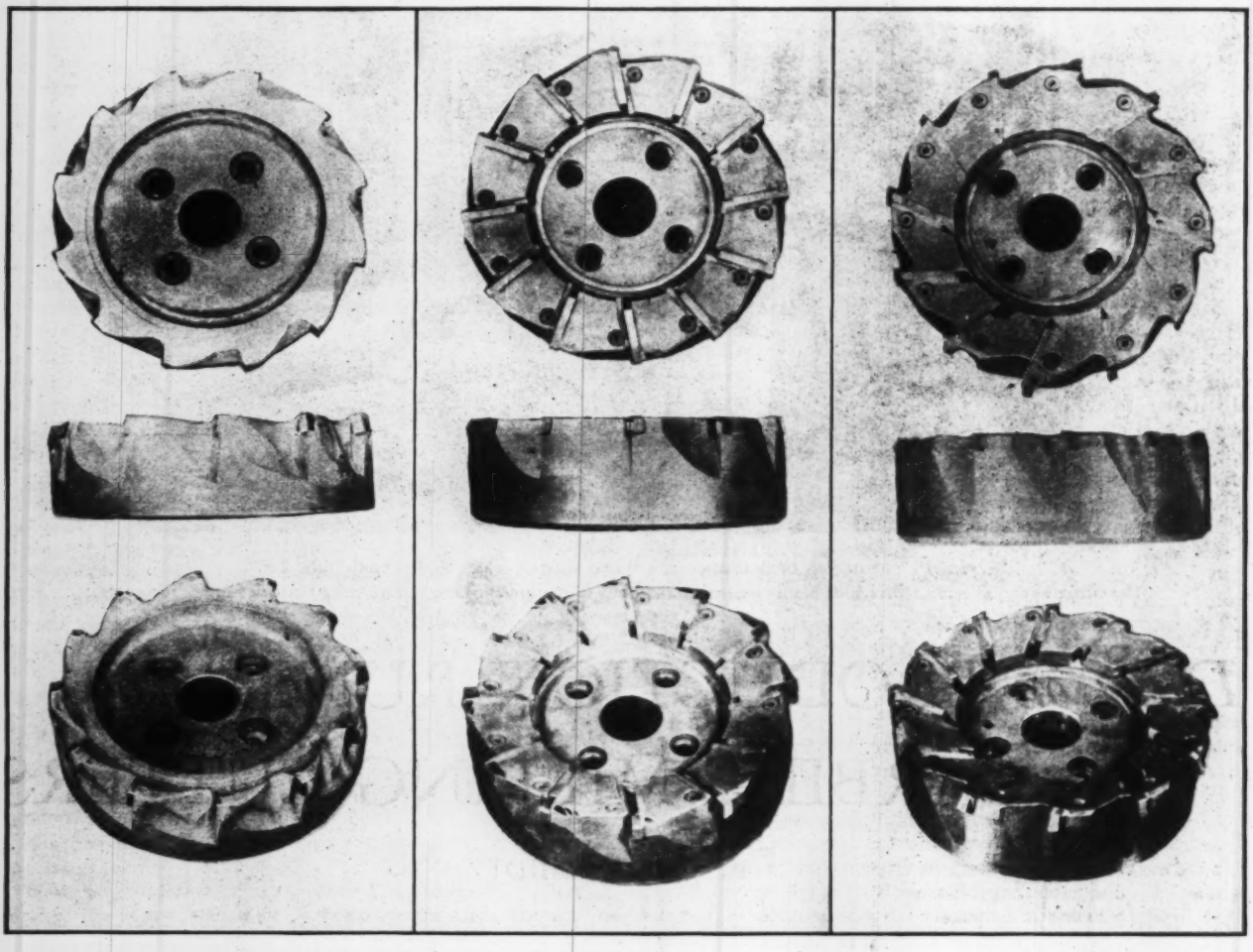

FIG. 2 10-IN. FACE-MILLING CUTTER 11B WITH 12 BRAZED CEMENTED CARBIDE CUTTING TIPS
(Radial rake angle, 7 deg negative; axial rake angle, 7 deg negative.)

FIG. 3 10-IN. FACE-MILLING CUTTER 11A WITH 12 SOLID CEMENTED CARBIDE CUTTING BLADES
(Radial rake angle, 7 deg negative; axial rake angle, 7 deg negative.)

FIG. 4 10-IN. FACE-MILLING CUTTER 1 WITH 12 SOLID CEMENTED CARBIDE CUTTING BLADES
(Radial rake angle 15 deg positive. A negative radial rake face of 10 deg and 0.025 in. wide is provided at the peripheral cutting edge. The wedge is in back of the blade to provide uninterrupted chip-accommodation space.)

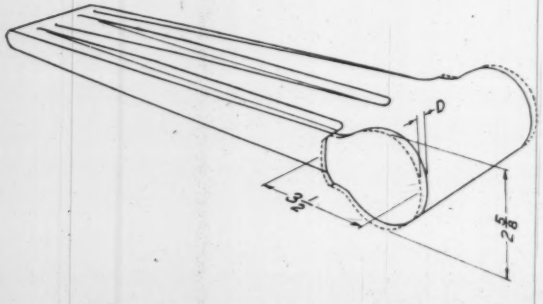

FIG. 5 DIMENSIONS OF CUT IN MILLING HINGE END
(Depth, D, varied from $^1/_8$ to $^{13}/_{32}$ in.)

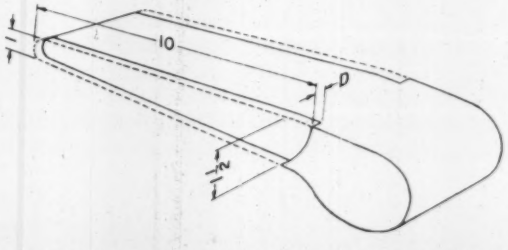

FIG. 6 DIMENSIONS OF CUT IN MILLING SIDES OF WING HINGE
Depth, D varied from $^1/_8$ to $^5/_{16}$ in.)

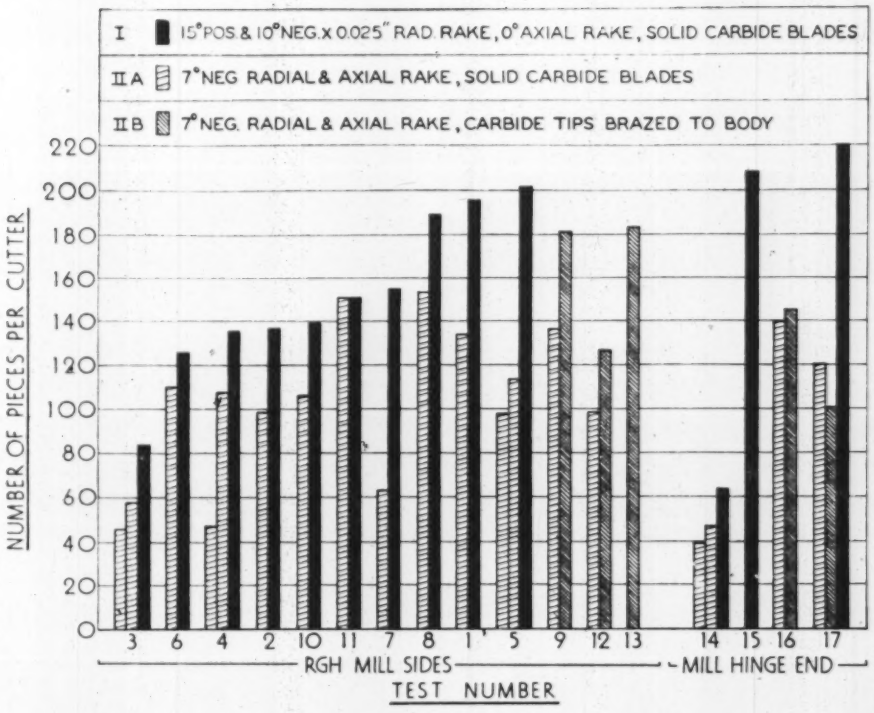
I 15°POS. & 10°NEG. x 0.025" RAD. RAKE, 0° AXIAL RAKE, SOLID CARBIDE BLADES
IIA 7°NEG. RADIAL & AXIAL RAKE, SOLID CARBIDE BLADES
IIB 7°NEG. RADIAL & AXIAL RAKE, CARBIDE TIPS BRAZED TO BODY
NUMBER OF PIECES PER CUTTER
0 20 40 60 80 100 120 140 160 180 200 220
3 6 4 2 10 11 7 8 1' 5 9 12 13 14 15 16 17
RGH MILL SIDES
MILL HINGE END
TEST NUMBER

FIG. 7 GRAPHICAL REPRESENTATION OF TEST RESULTS

the peripheral land was used as an indication of dullness requiring cutter replacement.

Before this investigation was undertaken, a cutting speed of 524 sfpm was established as a standard with feeds ranging from 13 to 26 ipm. Feed rate was usually constant during any one test and was governed chiefly by the available machine power with the resulting feed per tooth in agreement with good milling practice.

The cutters shown in Figs. 2 and 3 were designed according to general recommendations for negative radial and axial rake angle cutters. They were of two distinct types: Cutter, Fig. 2, was of the brazed-tipped design in which the carbide tip was brazed directly to the cutter body; cutter, Fig. 3, in which solid carbide blades were mechanically held in the cutter body by wedges. The third cutter, Fig. 4, incorporated the design features previously mentioned, mainly the use of solid carbide blades held in the face of the cutter body by wedges, set at a positive secondary radial rake angle with a negative primary radial rake angle imposed at the peripheral cutting edge.

In the first two types of cutters, Figs. 2 and 3, 7-deg negative radial and axial rake angles were used. The third cutter, Fig. 4, was provided with a 15-deg positive secondary radial rake angle with a 10-deg negative primary radial rake angle 0.025 in. wide, imposed at the peripheral cutting edge.

From the tabulated test data, Table 1, it can be seen that the double radial rake angle cutter usually produced the greatest number of pieces before dulling and resulted in minimum power consumption. There is little variation between brazed and mechanically held carbide face-milling cutters provided with negative radial rake angles. Workpieces produced before dulling were approximately equal for the two latter types of cutters but considerably less than the combined-angle cutter production.

CHOICE BETWEEN BRAZED-TIP AND MECHANICALLY HELD BLADES

Since the work completed by the two cutters is about the same, a choice between brazed-tip and mechanically held blades would be based upon several factors not including tool life between regrinds. Among these factors would be the following: Initial cost of a brazed-tip cutter is less than the cost of a cutter designed with mechanically held blades; brazed-tip cutters are often affected detrimentally by the brazing operation and grinding into the body in regrinding operations, a factor not encountered in cutters provided with mechanically held blades; blades are more easily and quickly reset for regrinding or replaced in the cutter with mechanically held blades. After analyzing these factors, it is apparent that the cutter with mechanically held adjustable blades is the less expensive on long production runs.

From the test data, Table 1, a wide variation in the number of workpieces produced with each set of cutters can be noted. This occurred despite the fact that the workpieces were made of the same material and subjected to the same heat-treatment. Whenever possible two types of cutters were applied on the same lot of workpieces. In several instances only a single set, but more often two or three sets of cutters were necessary to finish a lot of about 200 pieces. However, those familiar with production will agree that these variations are not excessive. A graphical analysis of these tests is presented in Fig. 7.

In order to provide a complete picture of the advantages of the various types of cutters tested, a continuous check was kept on the amount of carbide used, repair, resetting, and resharpening time required for each cutter. In this respect also, the combined-angle cutter proved to be superior.

COMBINED-ANGLE CUTTER FAVORED BY OPERATORS

Because the machine operator was on a piecework, incentive, rate of pay, he was interested in producing as many pieces as possible with one set of cutters. Since the cutters shown in Figs. 2 and 3 failed more quickly than that in Fig. 4, the tendency on the part of the operator was to run the former cutters longer than was advisable to realize the maximum number of workpieces between cutter changes. Because the combined-

TABLE 1 TABULATED TEST DATA

DATA—CEMENTED CARBIDE FACE MILLING TESTS ON WING HINGES

ALL FACE MILLS 10-IN. DIAM., 12 TEETH—CUTTING SPEED 524 FPM (200 RPM)

Operation	Test No.	FEED		Depth of Cut Inch	FACE MILL I					FACE MILLS IIA & IIB					
		IPM	Inch per Tooth		No. of Pieces	Cu. In. Steel Removed	Cu. In. Removed per Blade	Impacts per Blade	Type of Wear	No. of Pieces	Cu. In. Steel Removed	Cu. In. Removed per Blade	Impacts Per Blade	Type of Wear	*IIB †2 Passes per Piece
RGH. MILL SIDES	1	26	0.0108	1/8	196	305	25.5	15,123	5	MACHINE STALLED					
		21	0.0088	1/8						134	210	17.5	12,689	5, 7, 8	
	2	21	0.0088	1/8	137	215	17.8	12,973	2, 7	98	155	12.9	9,375	2, 4, 5	
	3	26	0.0108	5/16	84	329	27.4	6,481	4, 7	MACHINE STALLED					
		16	0.0067	5/16						46	180	15.0	5,721	4, 5, 8	
		21	0.0088	5/16						58	225	18.8	5,492	4, 5	
	4	21	0.0088	1/4	135	422	35.2	12,784	4	47	148	12.3	4,451	6, 7	
		21	0.0088	1/4						108	338	28.2	10,227	6, 7	
	5	21	0.0088	1/8	201	314	26.1	19,034	3, 4	113	176	14.7	10,701	3, 4, 7	
		21	0.0088	1/8						97	151	12.6	9,186	3, 4, 7	
	6	21	0.0088	1/8	125	196	16.3	11,837	2, 7	110	173	14.4	10,417	2, 4, 5	
	7	21	0.0088	3/16	155	302	25.2	14,678	4	63	123	10.3	5,966	2, 4	
	8	21	0.0088	3/16	189	368	30.7	17,898	4	153	299	24.9	14,489	2, 4, 5	
	9	21	0.0088	5/32						181	354	29.4	17,140	4, 6	*
		21	0.0088	5/32						136	266	22.2	12,879	4, 6	
	10	21	0.0088	1/4	139	435	36.3	13,163	4	106	330	27.5	10,038	4, 5, 7	
	11	21	0.0088	1/4	151	413	34.4	14,299	4	151	413	34.4	14,299	2, 4, 5	
	12	21	0.0088	5/32						127	260	21.7	12,027	2, 4	*
		21	0.0088	5/32						98	200	16.7	9,280	2, 4	
	13	21	0.0088	5/32						183	357	29.7	17,330	2, 4	*
RGH. MILL HINGE END	14	13	0.0054	13/32	63	162	13.5	3,160	2	MACHINE STALLED					
		13	0.0054	13/64						38	98	8.2	3,812	7	†
		13	0.0054	13/64						46	120	10.0	4,614	7	†
	15	16	0.0067	1/4	208	333	27.7	8,408	1	MACHINE STALLED					
	16	16	0.0067	5/16						MACHINE STALLED					
		16	0.0067	5/32						139	284	23.7	11,238	2, 4, 5	†
		16	0.0067	5/32						145	292	24.3	11,722	2, 4	*†
	17	16	0.0067	3/16	220	264	22.0	8,893	2, 4						
		16	0.0067	1/8						120	96	8.0	4,851	2, 4	
		16	0.0067	1/8						100	80	6.7	4,042	2, 4, 7	*

TYPE OF WEAR

1—Land Wear
2—Corner Wear
3—Face Wear
4—1/32 In. Land Wear
5—Crater
6—Pronounced Corner Wear
7—Slight Chipping
8—Breakage of some Blades

Face Mill	Radial Rake	Axial Rake	Corner Angle	True Rake	Method of Holding Carbide
I	15° Pos. & 10° Neg. X 0.025"	0°	30°	8° 41′	Solid Carbide Blade Wedged in Back
IIA	7° Neg.	7° Neg.	15°	8° 33′	Solid Carbide Blade Wedged in Front
IIB	7° Neg.	7° Neg.	15°	8° 33′	Carbide Tips Brazed Directly to Body

angle cutters stood up well, they were usually removed from the machine when the land showed 1/32 in. of wear, the machine operator feeling that a satisfactory number of pieces had been produced with the cutter.

Before the cutters were returned to the grinding department for resharpening they were inspected and the type of wear was noted as shown in the last column of Table 1. After the data were evaluated, they helped to settle a number of questions concerning comparative tool life, regrinding, repair, and economy of the cutters tested.

Besides the particular data ascertained in these tests the following points were observed:

Production tests, although they will not show as uniform results as laboratory tests, are more convincing to the shopman.

Production milling tests have a better chance of succeeding if runs after laboratory tests have established the soundness and practicability of new principles.

Machine operators, even those working on a piece-rate basis, will co-operate if an investigation does not interfere with their earning capacity.

Milling cutters should be resharpened before they have completely failed; otherwise the expense of reconditioning them will be higher than any advantages gained in machining a greater number of workpieces.

The cutter, Fig. 4, with solid carbide blades wedged into the cutter body at a 15-deg positive radial rake angle, and provided at the cutting edge with a negative face of small width, performed as follows:

(*a*) Machined substantially more workpieces between grinds.

(*b*) Used cemented-carbide material more economically.

(*c*) Operated with less vibration and deflection of workpiece.

(*d*) Consumed less power, as shown by its ability to take heavier and deeper cuts without stalling the machine.

(*e*) Always produced an acceptable finish leaving no objectionable burr.

ACKNOWLEDGMENT

The co-operation of Messrs. Wm. Guintoli and of R. Barczak, also the assistance of J. R. Roubik and J. P. Bunce, all of the author's company, in following up and evaluating these tests is gratefully acknowledged.

Materials of Construction in the Petroleum Industry

(*Continued from page 424*)

pressure vessels of the type being considered are not failures resulting from creep at high temperatures, nor from high operating stresses. In fact, the failures do not occur in the direction which represents the highest operating stress, nor do they occur at the high temperatures of operation but rather at temperatures in which the long- and short-time strengths of steel vary only slightly. Failure actually occurs in the transverse direction of the vessel where operating stresses are considered to be only one half the maximum stress. They are temperature differential stresses and occur always in tension and in the direction which represents the stiffest resistance to change of shape of the vessel contour due to temperature changes.

In the oil industry, and particularly in that part of the cracking process of refining in which a large amount of coke is to be cooled down for removal, the operating cycle often results in the quenching of a vessel on the inside. Because of the temperature of the steel at the start of quenching, the vessel diameter is larger than it will be when cold. The cooling is skin-deep at first and gradually progresses through the vessel wall. The inner surface is cooled, while the remainder is relatively hot, and this may result in stretching the steel on the inner surface beyond its elastic limit in tension, with the consequence that when the remainder of the wall thickness is cooled the vessel diameter will be very slightly increased. The effect is that with each cooling cycle the vessel grows a slight amount. The thicker the vessel becomes, the greater the amount of growth per cycle, because the temperature differential through a thicker wall is greater, and therefore the stress differentials are also greater.

If, however, the temperature differential is such that the stresses are not above the yield point of the steel, then the vessel growth is negligible. The thinner the vessel wall, therefore, the less the stress differential and the less the grief encountered. Hence if a vessel operates at 900 F, and is made of steel which is twice as strong at that temperature as another more common steel, the vessel wall can be one half the thickness and so be a safer vessel when operated under the conditions described.

The oil industry has overcome the difficulty mentioned by building units employing multiple reaction chambers so that one may be in the operating cycle while one or more are out of service, giving sufficient time for slow cooling and in this manner, eliminating the tendency to rupture.

The author has encountered this same problem in hot-oil pumps and in cylinders of large Diesel engines in which the cooling rates through the thickness of the cylinders or pistons are too rapid for the metal thickness employed. A great many engineering problems are of this character.

GENERAL

The general problem of materials in the petroleum industry applies with very little difference to many other industries. The solution of numerous difficulties is brought about by proceeding from a knowledge of the requirements of a new process and the experience in the application of materials to known conditions of service in other similar processes. There is a certain amount of experiment associated with producing any new advancement but if simple tests are made to simulate the conditions of the anticipated service, it is usually not long before a solution unfolds itself. If the new process is economically right it then becomes important to bring the equipment to the most appropriate degree of efficient application of materials.

The author is greatly interested in producing equipment for the petroleum industry. His experience largely covers casing, refinery equipment, and storage and transportation tanks, although a considerable part of it has been with hot-oil pumps, heating tubes, and problems associated with temperature differential stresses. The attempt has been made here to bring about discussion among petroleum engineers for the benefit of the industry. Healthy open-hearted discussion, together with a clear recognition of the problems met in the application of materials to the petroleum industry, will do much to speed its progress.

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PRODUCTION *and* DISTRIBUTION *of* LUMBER *by* SMALL MILLS

By R. J. HOYLE[1]

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LOOKING back over a rather long period of years, it can be said that in general the supply of lumber has been greater than the demand, and we know that this situation results in more or less of a buyer's market. There have been short periods of a few months or a year when the lumber-manufacturing business has been good and profits have been made, but these good periods are few and far between. For the period of the war the demand for lumber has been greater than the supply and that was why the War Production Board wrote its Lumber Control Order L-335, which provided lumber for war before civilian needs. This order was rescinded September 30, 1945. The Office of Price Administration has seen to it that the millmen's profits, if any, were small, and furthermore it seems likely that O.P.A. will continue with its price control for some time.

LUMBER INDUSTRY BESET WITH DIFFICULTIES

With the ending of the war, many lumber users felt that lumber would be much easier to get and that many of their wartime difficulties concerning lumber would soon be over. So far the situation is about as tight as it was during the war and production is on the decline. Lumber users and distributors, whether wholesale or retail, are having their troubles and as yet there seems to be little hope on the horizon. The war ended with inventories at an all-time low ebb. There was practically no stock of green or dry lumber anywhere. A great many of the large western mills have been closed because of strikes. The southern mills have lost labor because labor can now shift to other higher-paid lines of work. Weather conditions in other areas have hampered or closed mills and still others are not up to their normal production because of badly worn equipment which has not yet been repaired or replaced, or unavailable equipment. The quality of man power in the woods and mills, as well as the quantity, are also below normal.

Quite a few mills of the medium to small size went out of business 2 or 3 years ago when they found it impractical to operate in the face of O.P.A., and many other obstacles. These mills have not reopened yet and some of the larger ones that did operate chiefly because of patriotism may soon close, if they have not already, because the going is too hard and the profits too small.

For these reasons it is easy to understand why the supply of lumber is not adequate for our needs. Early in 1945, W.P.B. estimated the year's production would be 29,500,000,000 fbm, but recently, even though the war has been over for some time, the final record for the year may be only 27,000,000,000 fbm. With this low production and having no stocks to draw on, the users of lumber are wondering what they can do to get lumber.

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MILLS IN NEW YORK STATE

Small, medium, and large mills have been mentioned. These are relative terms and will vary in different parts of the country, so let us check up on mill sizes. Take New York State in 1942, as an example. These mills are at the very dooryard of the greatest lumber-consuming market in the world. There are 1331 sawmills in New York State. Of these, 840 produce less than 50,000 fbm per year, and 250 mills produce from 50,000 to 200,000 fbm per year. These 1090 mills are only part-time operators and many of them do a pretty poor job of making and merchandising lumber. In this paper, 1090 establishments are considered to be small mills. This leaves 241 mills that produce over 200,000 fbm per year. These 241 largest mills in the state can be broken down as follows: 175 produce from 200,000 to 1,000,000 fbm per year; 62 produce from 1,000,000 to 5,000,000 fbm; and 4 produce over 5,000,000 fbm. Let us call the four mills producing over 5,000,000 fbm large mills, and the others in between, which are 237 in number, we will call the medium-size mills.

These medium-size mills produce from 200,000 to 5,000,000 fbm per year. The lumber produced by these 1331 mills in 1942 is reported as 277,000,000 fbm. Of this, 129,000,000 fbm was softwood and 148,000,000 fbm was hardwood. The average sawmill in New York State cut 203,000 fbm of lumber in 1943, and in the same year the average mill in the United States cut 934,000 fbm.

We might discuss at great length production practices of different sizes of mills, grading practices, costs, prices, and merchandising methods. Space does not permit all of these details. Suffice it to say that in a region such as the Northeast we find a little or much variation in some of these practices and conditions between Maine and Pennsylvania, or New York and New Jersey. Practices and conditions in one state may be very different from the next state. What is true in the Adirondacks may not be true in the central part of the state. Again, conditions and practices may be quite similar in widely scattered areas.

Small mills, especially those 1090 smallest ones, have the advantage in that they can get in or out of business relatively easily when business is good or poor, and that is what many of them do. Many small operators and some medium size ones have little or no investment in timber, and the mill and trucks and equipment can generally be sold or bought in a short time, a comparatively small amount of money being involved. If the mill and equipment are not sold, they may remain idle for a while with no great burden of overhead expense.

During the war, green lumber was in good demand. This meant that millmen did not need to hold lumber from 2 to 12 months to season. Piles of seasoning lumber mean that piles of dollars are necessary to carry this lumber. Because trees could often be cut, sawed, and sold in a matter of days during the war, less capital than usual was required to get started in the lumber business. Some of these companies with little capital will drop out just as soon as the going gets a little

difficult. Some of the former sawmill men may again return to the lumber business if prices and conditions finally are settled and there appears to be some opportunity for profit.

PRICES FOR STANDING TIMBER AT HIGH LEVELS

Another situation that is tending to put millmen out of business is the following:

Prices of standing timber doubled and tripled in many cases during the war, and these prices have not declined. Labor and other costs have kept increasing, and at the same time the O.P.A. ceiling prices of logs and lumber have remained low and inadequate. Sawmills that buy logs are having trouble in getting logs at ceilings. Some mills that had a backlog of timber bought at prewar prices have been able to continue thus far, but this supply of stumpage in many cases is exhausted and the replacement prices are prohibitive. When the costs of operation exceed ceiling prices, the result is black market, operating losses, or going out of business. It may be argued that many small and medium mills do not operate efficiently and thus it is no wonder that their costs are high. This is no doubt often true but when they are doing the best they can and still cannot make money, it is evident many are going to close and the total result is a declining lumber production.

During the war when lumber users were in great need of anything that could be called a board, regardless of grade, quality of manufacture, or moisture content, this lumber was eagerly taken and with little argument about price. The small sawmills could sell their lumber just as well as the large sawmills. In fairness to the small mill, it should be said that size of mill does not necessarily indicate good lumber, but it often does.

Now that the war is over, many lumber users are shifting their lines of manufacture and new problems of locating sources of supply are arising. Some people are trying to find a small or medium mill somewhere that will be their source of supply at least until such a time as the larger mills or wholesalers can again supply their needs. It may be possible to find these mills but it must be realized that there may be many difficulties in buying this lumber direct from these mills.

HOW THE MILLS OPERATE

Small Mills. Perhaps we can understand the situation better if we observe first how these mills operate. Take the 840 mills in New York State that cut less than 50,000 fbm a year. This is a mill that sets out in the lot, rotting and rusting. This mill runs from 1 to 20 days a year, these days may be consecutive or in several different periods. The logs are cut at odd times and may lie around 6 months or longer, deteriorating before being sawed. Some of these logs may be owned by farmers who have hauled them to the mill for custom sawing, and this lumber is usually not for sale. The lumber owned by the millman may be partly for his own use or for sale. That which is sold is usually sold locally to a farmer or a factory. It usually consists of 5 to 10 different species and is probably sawed in several thicknesses. It consists of a little of this and that and not much of anything in particular.

Medium-Size Mills. What about the next larger group of mills, those 250 that cut from 50,000 to 200,000 fbm per year? They operate very much the same as the first group, only on a little larger scale. As a class they can make lumber a little better and have a little more of each kind for sale, but very few of them can grade it, nor do they have enough of any one kind, size, or grade to be of interest to most users, except a few local customers who sometimes can take such a mixture. Some of the larger mills in this group sell their output to wholesalers, while others sell to local woodworking factories.

The Larger Mills. The remainder of the mills, 241 in number, produce over 200,000 fbm per year and are the larger more dependable mills, but even many of them make much poor lumber; furthermore, many do a poor job of grading if they attempt to grade at all. Most of these mills sell their lumber to wholesalers or to local lumber users. It is probably safe to say that the majority of these 241 mills normally merchandise their lumber through wholesalers whom they have come to know and more or less depend upon for most of their outlet.

FUNCTION OF THE LUMBER WHOLESALER

Since the wholesaler is playing such an important part in the business of the sawmills and users of lumber, it seems desirable to explain briefly what functions and services he performs. Sawmill men are primarily manufacturers and not merchandisers. Merchandising of lumber is a big business. It is usually too big for the small- and medium-millmen, and that is why the wholesaler of lumber has made a place for himself. From 60 to 80 per cent of all lumber in the United States is normally sold through wholesalers. There are different kinds of wholesalers. Some have yards and some do not. Those with yards have concentration yards and others have distribution yards.

Concentration Yards. These yards are especially active in the South where there are many small and medium mills that are poorly financed. Some of these concentration yards have dry kilns and planing-mill facilities, and some may specialize in only one species. They will edge, trim, sort, and otherwise properly prepare the lumber for the market.

Wholesaler With Distribution Yard. The wholesaler who has a distribution yard is usually in a city or a large lumber-consuming center. He carries good stocks of lumber and can deliver promptly. He usually buys his lumber from larger mills.

Wholesaler Without Distribution Yard. The wholesaler who has no yard is by far in the majority. He ships direct from sawmill to user. He knows the lumber buyers and their particular needs, and he keeps in close touch with them. He also knows the mills and what they can and will produce, for he visits them frequently. This wholesaler with no yard, in normal times quite frequently advances money, or in one way or another partially finances and advises the millman who frequently is in need of such assistance. When there is such financial assistance, the wholesaler sells the entire output of the mill. Some wholesalers receive orders from buyers and turn them over to mills that can supply the lumber. This business is usually done at a fee of 8 per cent. Wholesalers with no yards operate in various ways which have not been mentioned, but it is his knowledge of supplies and markets plus his financial assistance oftentimes to consumer and dealer as well as to the mill that makes him an important cog in the lumber industry.

The lumber wholesalers with or without yards have had some difficult times. This was especially true in the days of the first world war, again during N.R.A. times, and then in the recent war. During the war, the Central Procurement Agency bought the lumber for the various government agencies. Added to this loss of business to wholesalers, the demand for lumber has been so much greater than the supply that many mills sold direct to the lumber-using industries. The Office of Price Administration set ceiling prices on lumber and did not recognize wholesalers' services. Although some wholesalers were forced out of business, the majority continued to do business and served the nation well in helping to get the greatly needed lumber to our war fronts. The lumber wholesaler is still in business and will continue in business because the mills and the buyers of lumber need his services.

There is another group of men known as "commission lumber salesmen." They usually represent several mills and are paid a percentage by the mills for their work. The commission man spends most of his time visiting his customers and selling the lumber which his several mills have.

Sales Organizations at Large Mills. Large mills may have their own sales organization which may consist of one or several men. Some millmen sell their own lumber, and they may also buy and sell lumber produced by several other mills in the vicinity. In such cases they are lumber wholesalers as well as manufacturers. This lumber may be brought into their plant where it is sorted, seasoned, trimmed, surfaced or worked as desired, before being sold, or it may be shipped direct from the mill where it is manufactured to the buyer. There are many combinations of ways that lumber is merchandised and these depend on custom and conditions.

The user of lumber some time or other gets the idea that he can buy his lumber at a lower price by going direct to the small or medium millman. In most cases this is not a good policy. In fact, in the end it may cost more to buy lumber direct, especially when buying from small and medium mills. In the first place, it will cost from $8000 to $10,000 a year to employ a qualified lumber buyer if he can be found. This buyer will need to travel from mill to mill a good deal of the time. Lumber cannot be bought satisfactorily by hiring a stenographer and sending out lists of requirements to a large number of mills, for soon there will be misunderstanding, dissatisfaction, argument, and lawsuits. Buyers will want only certain species, grades, and sizes, but the millman wants to sell all his lumber. He wants to sell his beech, elm, and No. 3 Com. and not just the cream. Few millmen have the time or the ability to travel around and find buyers for all their sizes, grades, and species. The millman has trouble enough in buying timber, getting out logs, and sawing lumber. He is usually glad to sell his lumber to a wholesaler who will take all of the product off his hands and pay for it. This is a service which the millman likes. In fact it is often vital to his existence.

FUTURE AVAILABILITY OF LUMBER

We are facing a shortage of lumber for some months and a brisk demand for some years. Some items may not appear in inventories for 2 or 3 years. Buyers may have to scramble to get what they want, but in so far as can be seen, lumber in the future as in the past, will continue to move through the usual channels, and the wholesaler will continue to be the main channel. There have always been a few lumber users who have gone into the sawmill business to supply their own needs. The logging and sawmill business is faced with many hazards. It is a low-wage, low-profit, high-risk business that should not be undertaken without very careful study and sound advice from competent people. Several lumber users could be mentioned who have gone into the sawmill business in New York State before and during the war only to learn that it was cheaper to buy their lumber. A company may understand how to manufacture furniture, boxes, radio cabinets, etc., but this is not an indication that this company will be successful in the logging and sawmill business. The lumber business has many things peculiar unto itself, and when these problems, practices, and situations are understood by the lumber buyer, he is in a better position to acquire his needs.

NEW YORK STATE COLLEGE OF FORESTRY MARKETING SERVICE

It might be of interest to some to know about a marketing service of the New York State College of Forestry that has been functioning for 30 years. Its primary reason for existence is that it helps the small and medium man. This service is, however, often helpful to the larger company. When people want to buy or sell timber, logs, lumber, forest products, woodworking machinery, etc., they write the college and tell us what they want to buy or sell. This item is listed in a mimeographed sheet called a Marketing Bulletin that is mailed out about every 6 or 7 weeks. Each bulletin contains about 45 items. The mailing list is chiefly in New York State, but there are some from neighboring states. The present mailing list has 2600 names and consists of sawmills, timber owners, wood-using industries, loggers, wholesalers, and some others. This bulletin puts producer and consumer in touch with each other at no cost, and frequently sales result.

With each bulletin one or two sheets of material are included which deal with items that are of interest, especially to small companies, concerning ideas, developments, trends, practices, etc. For the past 2 years these have dealt entirely with government regulations affecting the forest and lumber industries.

The kind of items in the Marketing Bulletin will vary with the market. For instance, in dull times there are quite a few items of lumber and timber for sale. During the war there have been many wanted items of machinery. The many bits of assistance and service which we render the taxpayers of New York State through this Wood Utilization Service, and the letters of appreciation which we receive for service rendered have convinced us that the service is appreciated and is worth while.

War Secrets Available

WAR-TIME technological data, of both the enemy and the United States, are being made available by the government to aid American industry and science. The information is being released by the Department of Commerce, Office of the Publication Board, Washington, D. C., for the first time by means of a "Bibliography of Scientific and Industrial Reports," a weekly listing of American and captured German scientific and technical information. Prices of the reports range from ten cents to $100, depending upon whether the information is mimeographed, photostated, or microfilmed—and its length.

When the United States invaded Germany, her industrial secrets were among the first targets. What new discoveries had German scientists made? What new processes had they developed? What German products were better than ours? American scientists and technicians sent into German factories questioned German personnel and studied German documents. As long as war continued reports went into "Secret" files.

The President has directed that secrecy restrictions be lifted wherever possible, on American as well as German and other foreign information. The Office of the Publication Board was created to distribute the material. More than 2500 reports had been released by February 28; 14,000 more are awaiting release.

The enemy and American reports range in size from one page to documents of 300 pages, filled with photographs, drawings, blueprints, and graphs. They cover all fields of industry and research, such as, testing methods, chemical research, metal finishing, tools, medical research, aircraft, engines, textiles, plastics, and hundreds of other subjects.

To tell American business what is available, the O.P.B. publishes the *Bibliography* weekly. Each report is listed by subject and author. Each listing includes an abstract of the report and its price.

Because the future size of issues of the *Bibliography* cannot be predicted, an annual subscription price cannot be established. However, a $10 deposit sent to the Superintendent of Documents, Washington 25, D. C., will cover about nine months.

The O.P.B. announces that it does not censor or edit the material and does not accept responsibility for completeness, technical accuracy, or the opinions expressed. Science and business must make their own evaluations.

Many of the processes described in the reports may be covered by patents. O.P.B. recommends the usual patent search before practical application is made.

LEADERSHIP *by* PERSUASION

By DAVID C. PRINCE

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THE problem of leadership may be divided into three parts: (1) The will to lead toward a goal; (2) the know-how required to proceed in the direction of the goal; and (3) the knowledge of how to obtain a following.

Almost by definition a leader must wish to lead somewhere. He must have the vision that his goal can be attained and that it is worth a struggle.

BELIEVING IN THE IMPOSSIBLE

A short while ago a young Chinese engineer came into my office. He had worked for the General Electric Company during the war, and during that period that his own country was isolated so he could not return to it. With the end of the war he was returning home and came to tell me good-by. Before he left he asked me if I were optimistic about the future. Without much thought, I told him that I was; whereupon he asked how I could logically be optimistic about the future. Is it not true, he said, that human nature has not changed—that every other war, although followed by a temporary peace, has been in turn followed by further wars? How then could anyone logically be optimistic about the future? My first reaction was to quote from "Alice in Wonderland:"

"I can't believe *that*!" said Alice.

"Can't you?" the Queen said in a pitying tone. "Try again: Draw a long breath, and shut your eyes."

Alice laughed. "There's no use trying," she said. "One *can't* believe impossible things."

"I daresay you haven't had much practice," said the Queen. "When I was your age, I always did it for half an hour a day. Why, sometimes I've believed as many as six impossible things before breakfast."

This did not appeal to my Chinese friend as logic. But when we stop to think of it, were not most of the things that we regard as commonplace today impossible only a very short while ago? The power loom, the steam engine, the electric light, the automobile, the airplane. All of these were possible only a short time ago, and those who believed in them in the earliest stages were certainly believing something in their time generally regarded as impossible.

The existence of an undefended border to the North between the United States and Canada, and to the South between the United States and Mexico is a tribute to our faith in the United States in what is regarded elsewhere as impossible.

THE ROAD TO LEADERSHIP

Since we cannot know that any given goal is impossible of attainment, we must reorient our thinking to see what goals are worth a struggle. Hence in the process of training for leadership, the trainee should probably be started on his way by being assigned goals relatively easy of achievement. A horse will not jump a fence until it has first been taught to step over a rope laid on the ground, then over a bar suspended a few inches above the ground and gradually raised until the horse can put forth his full powers surmounting obstacles in his path.

By a similar procedure, the neophyte in leadership should have his confidence built up by being assigned problems in leadership, beginning very simply where success is sure and then proceeding to more and more difficult cases.

A draft horse must be taught to throw his full weight against a heavy load—which may not budge at all—and still not give up. The leader must likewise be developed to a point where he is not discouraged by his inability to solve an important problem but will continue to try and try again as long as he believes the solution of the problem to be really worth the effort.

Little time need be devoted here to the matter of know-how, i.e., the ways and means whereby the goal may be reached. Our whole technical educational system is devoted to teaching know-how. The achievements of our engineers in solving the production problems of the war and the associated logistic problems bear ample testimony to our pre-eminence in that direction. It is on account of our know-how that world leadership is being almost forced upon us; and there is very little doubt in anyone's mind that, in so far as technical know-how is concerned, we shall not fail.

A LEADER MUST HAVE A FOLLOWING

Securing followership, however, may be quite another matter. It is not enough that a leader may have selected a goal worthy of attainment, that he may have confidence that it can be attained, and that he may know the necessary steps to progress toward such a goal. If he cannot secure a following, he is not a leader.

However, securing a following is, in its turn, a technical problem. A great many books have been written on the subject which was so popularized by Dale Carnegie in his "How to Win Friends and Influence People." In fact, the idea may have been oversold. The impression may have been created that it is only necessary to spend a half an hour with a popular book to become a supersalesman. As a matter of fact, most of the books on the subject of persuasion deal effectively with only one or two points; whereas an individual of great persuasive powers must be able to meet a wide variety of situations involving diverse personalities.

REQUIREMENTS OF LEADERSHIP

In order to secure a comprehensive coverage in this field it would seem likely that an approach should be made comparable to the approach of a professor writing a college textbook. The textbook endeavors to cover, at least in outline form, an entire field.

For a number of years our company has conducted sales courses which have been designed co-operatively with the Sales Analysis Institute. We have also profited greatly from courses in the psychology of supervision; also worked out with the Sales Analysis Institute and adapted to the needs of foremen.

A comprehensive general approach is still lacking, although enough progress has been made to indicate a comprehensive outline. This outline is as follows:

Appeals to reason:

1 Benefit to the other fellow
2 Good qualities of proposal
3 Loss to the other fellow

Contributed by the Committee on Education and Training for the Industries and presented at the Annual Meeting, New York, N. Y., November 26–29, 1945, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

4 Poor qualities of other proposals
5 Prestige (others are benefiting) precedent
6 Story (how others benefit)
7 Explanation (tell how)
8 Demonstration (show how)

Appeals to emotion:

9 Manners (yours affect the other fellow)
10 Assurance (yours is contagious)
11 Appeal to pride (satisfaction in job well done)
12 Good turn (one deserves another)
13 Understanding (know your man)

Obstacles:

14 Habits
15 Fear (of a new step)
16 Inertia (laziness)
17 Complaint (relevant or not)
18 Ignorance
19 Opposing influence
20 Time and timeliness
21 Difficult personality

Procedure:

22 Objective
23 Case analysis
24 Opening
25 Development of proposal
26 Question to measure progress
27 Request to secure action

Running all through this outline is the emphasis that must be placed upon the point of view. One's own reactions are relatively unimportant at all stages. Primary emphasis must be placed upon the point of view of the specific other fellow group from whom compliance is desired. Perhaps the rather brief headings in the outline should be amplified somewhat in the interests of clarity.

APPEALS TO REASON

Man is differentiated from the lower animals by his ability to reason. Therefore, appeals to his reason are the most basic appeals to a human being.

1 *Benefit to the Other Fellow.* The effort is made to draw a distinction between qualities inherent in the proposal itself and the benefits which flow from those qualities to the subject. For instance, a gold coin is of no value whatsoever unless there are goods or services available to buy with that gold coin. Money by itself, regardless of its qualities, is not a benefit at all. A benefit, therefore, is some enjoyment received by the other fellow as a result of compliance.

2 *Good Qualities of Proposal.* Good qualities are those properties inherent in the proposal which provide logical reasons why the subject may expect to enjoy the benefits offered. Thus in clothing, high-quality material provides benefits in the form of handsome appearance, long wear, etc. A man who has the good qualities of being intelligent, conscientious, and a hard worker would provide benefits for you only if he works for you.

3 *Loss to the Other Fellow.* Most of our actions are motivated by the hope of reward and also by the fear of punishment. The benefits of item 1 constitute rewards. The losses of item 3 constitute the punishments likely to result from a failure of the prospect to agree with the proposed action. Such a loss must again be a personal loss.

4 *Poor Qualities of Other Proposals.* Just as there must be good qualities furnishing reasons why if one is to expect a benefit, so there must be poor qualities furnishing reasons why if one must expect a loss.

5 *Prestige (Others Are Benefiting) Precedent.* Most of our experience is based on trial and error. However, we early learn that many of the errors can be avoided if someone else has made the trial and found it to be a success. Therefore one of the strongest appeals to reason on any course of action is to show that others have taken the same action and that the results have been good.

6 *Story (How Others Benefit).* If the desired action contemplates a succession of steps, the logical sequence can best be developed in the form of a story which recites the various steps to be taken in their proper order and ends up with the benefits obtained. Such a story may be a historic record, in which case it differs but little from the prestige appeal of item 5. However, such a story may also be hypothetical, serving to put in their proper order and perspective a fairly involved set of ideas.

7 *Explanation (Tell How).* In our present mechanical age it goes without saying that any procedure beyond the most elementary requires an explanation. Throughout the war this has been developed to a very high degree in the briefing technique universally employed. Very elaborate explanations are made to all the members of the team covering all the steps that have to be taken and what may happen at each step.

8 *Demonstration (Show How).* Where possible, the best appeal to reason is an actual demonstration of the procedure proving conclusively that the benefits do, as a matter of fact, flow from the good qualities of the proposal.

Items 1 through 8 can be amplified with different examples for every different situation. A good textbook on the subject should include enough examples in different situations so that the trainee may learn to draw his own from any situation with which he is confronted or experience through which he passes.

APPEALS TO EMOTION

Appeals to emotion might seem unnecessary among highly intelligent and educated people. However, if we are to be honest with ourselves, we must recognize that none of us is entirely free from emotional appeals. Appeals for charity are almost entirely emotional. The entire amusement industry is, of course, built on emotional appeal and nothing else. Even in our day-to-day contacts regarding matters which would appear to be entirely within the realm of reason, emotions also play a part.

9 *Manners (Yours Affect the Other Fellow.)* Anyone of us will do what he thinks is the right thing with greater alacrity if the manners of those who ask him to do it are agreeable to him. Manners are not absolute. The manners of the drawing room and the dinner table may not be suitable for the shop, just as manners suitable at a funeral are different from those at a wedding. The principal point is that the manners of the leader must be acceptable to those led, under the specific conditions of the situation.

10 *Assurance (Yours Is Contagious).* Individuals hesitate to take a course of action unless they are assured of success. That assurance is one of the principal elements of leadership. The leader knows in his heart that the proposed action is possible and that the results will be beneficial. That assurance radiates to those about him.

11 *Appeal to Pride (Satisfaction in Job Well Done)*. All of us like to be held in high esteem by others. To justify that esteem we may put forth every effort of which we are capable. Satisfaction in a job well done is one of our rewards.

12 *Good Turn (One Deserves Another)*. We all like to live in a free world where people are kind and generous to one another. By the interchange of good turns feelings of friendship are established. Many of us will go to any lengths for a friend, where we certainly would not for a stranger.

13 *Understanding (Know Your Man)*. Although all of us respond to the general emotional appeals, there are always certain appeals peculiarly effective to certain individuals. In dealing with strangers these appeals are not available; but, especially where the leader must contact the same individual over and over, his contacts will be greatly improved by an understanding of what constitutes the other individual: What things can he do, what things does he like to do, what troubles and frustations has he had, etc.? All the past experiences of any individual become a part of him, and an understanding of those experiences that make the man is one of the greatest aids in dealing with him.

In listing the foregoing appeals to emotion, one appeal has been deliberately omitted; that is the threat of bodily harm. The early success of the Third Reich was built very largely on that one appeal. The old slogan, "Spare the rod and spoil the child," rests on the same basis. Today we believe that the better technique emphasizes the reward to the almost complete exclusion of the punishment, although there are of course many cases where recourse must be had to punishment as a last resort.

OBSTACLES

We know to our sorrow that we are not always successful in our appeals to reason and emotion, and no coverage of the subject can therefore be complete without mention of those obstacles which prevent success. A number of these have been listed as follows:

14 *Habits*. Whenever one is asked to do something different from what he is in the habit of doing, the habit asserts itself as an obstacle. Even without thinking, we continue to make decisions based on habit which may not be at all justified by the situation of the moment.

15 *Fear (of a New Step)*. Whenever one does something he has not done before, there is some small fear as to the outcome. When one is asked to do something which he has tried in the past with unpleasant consequences, fear may be very real. There is probably always some element of fear involved when one is asked to do anything that he has not done before.

16 *Inertia (Laziness)*. The small child bursting with energy comes to his mother and asks what he may do. Most of us in later life are confronted with so many things that we must do that we naturally react against making any new effort. It may be laziness—it may be merely inertia—but it is, in any case, an obstacle to activity.

17 *Complaint (Relevant or Not)*. When we are asked to do something we have tried to do before with unsatisfactory consequences, we naturally complain about trying it again. On days when everything about the world seems to be unsatisfactory, we have so many things to complain of that it is hard to fix our attention on compliance with some new demand whether or not it is related to the subjects of complaint.

18 *Ignorance*. We cannot do things about which we do not know. Therefore, until ignorance is replaced by enlightenment, it constitutes an obstacle to progress.

19 *Opposing Influence*. No leader has a monopoly on leadership. There are always other individuals or situations which bring influence in the opposite direction, and these opposing influences must be overcome before acquiescence is obtained.

20 *Time and Timeliness*. To do most things takes time. To get an idea into anyone's head takes time. Therefore mere time itself constitutes an obstacle to instant action. Likewise, there is a timeliness to things. We can be persuaded to do more things when we are fresh in the morning than when we are tired at the end of a long day's work, etc.

21 *Difficult Personality*. Some people have lived such lives of misfortune and frustration that their reaction to any proposal is negative. This negativistic tendency is a serious obstacle which, in the extreme cases, is overcome only by asking the individual to perform the reverse function to that which is desired. In general, dealing with a difficult personality requires both interest and sympathy.

PROCEDURE

It is not enough to know all the factors pro and con affecting both reason and emotion unless we know what to do with the material after we get it. This comes under the heading of "procedure." The leader must of course first pick his *objective* (22). Having picked his objective, he must make an *analysis* (23), including all the necessary appeals to reason and emotion, especially emphasizing those appeals calculated to overcome the obstacles known to exist. The relevant information must then be arranged strategically.

In a letter or advertisement the case must be presented from beginning to end in one document. In the more general case of personal contacts the whole strategy may be outlined in advance, but the order of presentation may be fitted into the case as it develops. The first thing to do is to feel out the situation to determine what sort of man one is dealing with, if he is a stranger; or, if he is an acquaintenance, to find out his mood of the moment. Next, the proposition should be presented in the way most calculated to secure favorable *attention* (24).

25 *Development of Proposal*. From that point on the various appeals are introduced in what appears to be the most expedient manner.

26 *Question to Measure Progress*. Progress in developing the proposal should be checked at frequent intervals, asking questions if necessary to determine what acceptance the proposal is receiving. Just as the proof of the pudding in the case of a salesman is the signature on the dotted line, so the acceptance of a request for action is the ultimate objective of any contact. That request must be made if the subject is willing to give an affirmative answer. If he once gives an emphatic negative answer, the going from there on is much more difficult. If the favorable moment is passed by, the chances of a favorable response may become increasingly unlikely. The request for action is therefore the pay-off; and the subject's answer is the final proof of whether all the previous steps have been properly taken.

It is hoped that the question of persuasion may be dealt with both adequately and comprehensively. When it has been so dealt with, a study of the subject will justify considerable effort since, no matter how well conceived a leader's objective may be or how much he may know about the technique required to achieve the end, his work will still all go for naught unless he can persuade his followers to follow him.

TRAINING *for* LEADERSHIP

By BRIG. GENERAL H. R. KUTZ, U.S.A.

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IN early July, 1944, a month after D-Day in France, a very young captain in a Ranger infantry battalion found time to write a letter of advice and counsel to a lad who was about to enter the U. S. Military Academy at West Point. The captain was moved to write the letter because of his stark realization on D-Day of the vital importance of leadership to a soldier. He had every reason to know. He had landed on the Normandy beach with the first invasion wave; had been pinned to that narrow exposed beach by bitter deadly enemy fire. This is, in part, what the captain wrote to the young candidate:

"I dropped to the ground and tried to get my life belt off. I couldn't do it, so I stood up and wandered over to my radio operator and asked him to help me. He was lying on the rocks cringing with fear; he looked up, saw me, and said: 'Oh, sure, captain.' And then he stood up beside me and cut the thing off. From there on he was not afraid again, nor was I. I had seen in the first minute of combat what showing the complete lack of fear could do to your men.

"During the next five days that we were in the line I did a lot of foolish things, but they always had a purpose and always, looking back on them, it was my duty to do them. Once when I was walking forward toward an artillery barrage, a company in front of me actually broke and ran. I was in the midst of them. How could I stop them? I just yelled: 'What the hell are you all running for? If you've got to move to the rear, try walking; it saves energy.' They stopped running and looked a bit sheepish so I blasted them about the fine exhibition they had just made and had them hit the dirt by the side of the road. Then I took the company commander from the next company in line right up into the middle of the barrage. It had the desired effect. The first company couldn't stand to see someone else trying to take its place, and they began an advance that carried them right through the barrage.

"I realize as I read this back over," the captain concluded, "That it sounds as if I'm trying to make a hero of myself. But heroes are those who do things that are beyond the call of duty. I'm afraid that I never did anything that I considered beyond the call of duty. The things I did were minor compared to those which others did."

I leave it to the reader to decide whether the youngster was a hero. My purpose in telling this story is that it illustrates many elements of this elusive quality called leadership, and perhaps suggests the inherent difficulty in training men for leadership.

NO OVERSUPPLY OF LEADERS

The history student learns that the United States has never had an oversupply of real leaders. There have, indeed, been times when a critical need for military leadership existed. Our sorry record in the War of 1812, where for a time there was a new commander every month; Lincoln's desperate efforts during the dark days of 1862, when, in a period of 8 months he found it necessary to change commanders four times; these are cases in point in which we take no pride. Fortunately, however, men have always been found possessing in high degree those intangible but outstanding qualities of leadership.

These identical qualities are also manifest under conditions far removed from the grim but spectacular battlefield. We have always had capable leaders in religion, education, science, politics, industry, and labor as well as in war. The inherent qualities of true leadership are fundamentally the same, and are demonstrable not only under enemy fire but also in the workshop and in the office; in civil life as well as in the military service. They are equally vital in peace as they are in the successful prosecution of a war.

The pressing need in 1941 for an immediate and manyfold expansion of our Armed Forces, and the steps taken to create and place in operation at maximum capacity the necessary training establishments and installations are now quite well known. Our Ordnance problem required the training of hundreds of thousands of skilled ordnance specialists and technicians, and I'm reasonably sure that, in general, our experiences and methods were similar to those of the Navy and other branches of the Armed Forces which required large numbers of highly skilled technical experts.

Traditionally, in the case of officers, our young leaders were supplied yearly from the U. S. Military Academy, from R.O.T.C. institutions, and from carefully selected candidates, chiefly college graduates, in civil life and in the enlisted ranks. Noncommissioned officers were usually selected on the basis of demonstrated ability and proficiency, and received special training in Army schools. The numbers were comparatively small, they were readily assimilated by the Army, and their progressive training normally covered a period of years, not the woefully inadequate 13 (later 17) weeks available for selecting and training the vast number of leaders who had to come from the rank and file of our new and quite unseasoned citizen army. It was therefore necessary to establish officer-candidate schools and noncommissioned-officer schools with concentrated courses to provide the maximum of instruction in the minimum of time.

The basic military education of the soldier, and the transformation, in an all-too-brief period, of a technically untrained individual into a highly skilled ordnance specialist, these tasks we learned to accomplish successfully in our schools and training centers, thanks to the magnificent assistance rendered by those in the educational and industrial fields. But in our efforts to find badly needed guidance in attempting to solve the problem of what we termed "leadership training," representatives of industry were honest enough to state that they had little to offer in the way of practical leadership courses.

WHAT IS LEADERSHIP?

What is this "leadership" in which we are all so vitally interested? The dictionaries give a variety of definitions. To quote one: "Showing, exhibiting, or embodying a quality or state of going before, to lead, guide, conduct, or show the way—of having authority to precede and direct in some action, opinion, or movement, entitling one to rank, title, or appellation as a chief, commander, or captain."

Leadership is age-old. The problem of selecting and training men for leadership has occupied the minds and thoughts and has received the meticulous attention of distinguished

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leaders and planners from time immemorial. It has been chronicled and exemplified in histories, manuals, and in the biographies of the world's greatest men. Discussing leadership, however, is somewhat like talking about the wind which is better described through its effects than in its substance. Results, or lack of results, are more easily recognized than the causes which produce them. Perhaps we have all been too prone to accept as gospel the oft-repeated statement that "leaders are born—not made." Who can say to what extent leadership is inborn or acquired? There are so many intangibles in the character and personality of a leader. It may be a natural gift in a genius, certainly in men of destiny like Napoleon.

In any event, we were faced with an almost insoluble problem in human engineering which presented a real challenge to us in our endeavor to mass-produce embryo leaders by developing those qualities we so earnestly sought. How could we train men in a classroom to do what that young captain did? How could we teach men what should be done under varying circumstances, and inculcate in them the determination, sense of duty, or whatever you may wish to call that impelling force which prompts a man to go ahead and do what needs to be done, regardless of personal risk, without counting the cost?

I only wish I could report to you that, based on our experiences during the late war, we have a practical solution to this problem. However, I must confess that such is not the case, and I fear that we have little new to offer in the way of anything definite or concrete. We have tried hard, we have learned much, we have achieved some measure of success as judged by observed results. Successful leadership can be measured by the results obtained, by the morale and spirit of a command, by the implicit faith of men in their leader which inspires mutual confidence and sustains the collective effort of the group.

BASIC TRAINING IN MILITARY LEADERSHIP

We do know that there are certain qualities and traits of character in many men which make them adaptable to special training for leadership. Human beings vary widely in their basic characteristics, but we believe that young men can be remolded through exposure to selected opportunities and environment, and that encouraging results can be attained by appropriate training.

Thirteen weeks have only 91 days, and for most of the entire period so rugged was the pace that candidates did nothing but sleep, eat, and train—mostly train.

Candidates had to be trained to a superior proficiency in the basic arts and techniques of the soldier. An officer to command the respect of his men should know how to fire a rifle at least as well as his men, and should be able to march as far as any of his men. They also had to be technically qualified in ordnance maintenance and supply techniques and procedures; not necessarily to the level or degree of skill of key specialists, but to the point where they knew what a mechanic did, how long it took to do various jobs, and how to direct and administer the efforts of a crew of mechanics or group of clerks. They had to be trained to control, to discipline, to praise, to censure, to counsel, and, above all, how to spur men on when the going got tough. They had to develop those traits of character—honesty, dependability, pride, moral and physical stamina, common sense, discipline, judgment, self-confidence, and the social amenities that form the code of an officer. They were continually indoctrinated with the fact that leadership is an indispensable attribute of command.

We believe that it is impossible to teach leadership from textbooks. Candidates must be first inspired, and then helped in their efforts to demonstrate that they do possess qualities of leadership. We encouraged our candidates by assuring them that he who strives sincerely to earn the confidence of his men by emulating the traits of character and leadership he admires in his own leaders, will go far toward developing those selfsame qualities.

We carefully selected as our leadership instructors, officers who had previously demonstrated outstanding qualities of character and leadership—fine upstanding men of soldierly bearing, neatness, exemplary in their conduct and in their attitude toward personnel and duties, thus continuously setting the highest standards of perfection for candidates to emulate.

After careful analysis and observation, it soon became obvious to us that only the more capable of our candidates could meet the high standards of proficiency considered the minimum required for our junior officers and noncoms. Our raw material must perforce be more carefully selected.

PRESELECTING CANDIDATES

Preselection, we then decided, was of paramount importance in our leadership-training program. From the vast number of applicants, how were we to select those who had the inherent capacities for such practical leadership training as we could give? There was no simple yardstick available.

We used general classification tests which measured the level of intelligence and learning ability; interviews by boards of carefully selected experienced senior officers who sought to find those traits of character and personality that we deemed important; and review of past records, civilian and military, to reveal those individuals with such record of achievement as would indicate good leadership possibilities.

Our review boards interviewed men from every walk of life, men who had recently entered the Army, men who already had several years of service, men who had come into the Army as mature individuals, youths who had just graduated from high school. There was no set pattern, no established type of individual who applied for admission to our officer and noncommissioned-officer schools. They represented truly a cross section of American manhood.

Our standards were necessarily broad and somewhat flexible. We sought men of excellent character and personal integrity, of course. They must be literate, but not necessarily well educated by formal standards of education. They must be clean, alert, intelligent, and ambitious to undertake with courage and enthusiasm the responsibilities which all leaders must assume. They must be straightforward, earnest, sober, industrious, conscientious, trustworthy, forceful, and firm, yet temperate and just, patient and persevering. Those qualities were among the tangible obvious ones which we might be expected to seek.

But we tried to go further. We delved into a candidate's past for evidence of self-reliance and ability and willingness to think and act for himself and in behalf of others, be it through active participation in athletics in high school, in Boy Scout work, as a Sunday-school teacher, or in any form of community life. Was he the sort of lad who did things, or was he one who was prone to allow someone else to carry the ball, content to follow the line of least resistance?

There was in addition the inexplicable something about one lad as against another which stamped him, in the judgment of our mature examining officers, as one who had within him the ability to convey to others the eagerness, determination, the will to achieve, which he found within himself.

Of course, we couldn't be sure, even then. Preselection, by eliminating obvious misfits, insured the entry of a select group. The process, however, was not foolproof, and we are frank to admit that we made many mistakes in our preselection. Frequently undesirable and disqualifying traits, not previously discernible, appeared during training. The entire training

period was truly one continuous process of selection and observation. We expected failures, but insisted on maintaining the high standards we felt necessary. Actually, the percentage of washouts in our officer training schools varied, but averaged over 20 per cent. To date we have graduated from our officer-candidate school and commissioned as second lieutenants in the Ordnance Department some 13,250 men.

PERFECTING MILITARY AND TECHNICAL QUALITIES

Once the candidate had been selected, we concentrated our efforts on perfecting his military and technical proficiency, and on trying to develop in him the qualities we sought and which we fervently hoped and believed he possessed, however latent. We discovered early that frequently it was a matter of demonstrating to the man himself that he actually possessed the qualities we were seeking, showing him that he had never used, or perhaps never had realized his talents, resources, and capabilities.

We justified the strenuous period of intensive training, so essential to victory in war or to success in peace, on the ground that fellow officers and men had every right to expect our graduates to be well trained. We told them that they must demonstrate to leaders and followers alike that they possessed the art of leadership by exhibiting those qualities which inspire confidence in superiors and loyalty in subordinates.

While insisting on proper military discipline, the leadership instructors nevertheless endeavored to make the candidates feel at ease in solving practical leadership problems so as to encourage the display of leadership qualities by each individual.

The major portion of the leadership instruction consisted of actual demonstration and field performance rather than mere lectures or discussion. Candidates were at first given charge of small groups and gradually afforded opportunity to assume increasing responsibilities. We devised the most practical tests possible. They served to prove to a candidate, perhaps for the first time, that he could accept and satisfactorily discharge the responsibilities suddenly thrust upon him. On the drill field we sought to give a man confidence in his ability to take charge of a group of men, how to give orders, how to instruct, to learn the virtues of precision, to make quick decisions, to develop the bearing of a soldier. Practice marches, convoys, bivouacs, and field problems tested the experience gained in the classroom, the shop, or on the drill field. A candidate in command of a unit moving peacefully through a wild section of terrain suddenly faced a surprise enemy attack. What orders should he give for the protection of his men and equipment, for appropriate action against the enemy? Tested under practical emergencies, particularly those simulating conditions in the combat theaters, much can be learned about a man's leadership potential.

The organizational abilities of a candidate were tested by placing him in command of a unit with orders to set up a field installation to perform the vital repair and supply work which is the principal field job of ordnance. Actual performance in such situations enabled us to judge whether a candidate possessed the capabilities required in a field repair shop, supply depot, ammunition supply point, or motor-vehicle assembly line.

The acid test of the success of training is in the actual performance of the task or mission. The efficiency and ability of the leader is judged by his superiors on the success of his group in performing whatever mission may be assigned. Candidates were encouraged to consult their instructors during off-duty hours and discuss their problems, their ideas, their ambitions. We encouraged in them a thirst for knowledge, and eagerness and ambition on their part to qualify themselves on subjects other than those upon which they were currently engaged.

Even though our training time was woefully inadequate, we endeavored, whenever possible, to sacrifice speed in order to achieve thoroughness in preparation. We taught our trainees that the true leader must know instinctively his men—their qualifications and limitations—and how best to utilize their services in probable contingencies, and that he himself must ever be willing to go further and do more than his men, in order to accomplish the group mission.

OFFICER'S RESPONSIBILITY TO HIS MEN

We continually impressed upon a candidate the vital importance of a deep sense of personal responsibility for the instruction, care, welfare, morale, and state of preparedness of his group, and that he must be father, mentor, confidant, and counselor of his men, since they esteem highly the sympathetic interest of their leader in their personal welfare. Subordinates are anxious and willing to be led, but they must have faith and feel confidence in the competence of their leader and trust in his decisions. Such confidence, engendered in many ways, fostered group pride and esprit de corps.

We stressed the importance of making prompt decisions by insisting that the trainee select with confidence a single positive course of action, preferably the right or best, from several optional alternatives. He must accept responsibility and full consequences of his decision, despite mistakes and criticism. The timid soul makes no mistakes because he fears to make a decision or to take definite action. Our trainee was encouraged to admit his errors and profit by them—not to be licked by them, but to improve by restudy and self-criticism. We stressed the fact that loyalty stems from the top, that loyalty cannot be demanded or ordered by fiat, but is given unstintingly when inspired by the leader, who must himself be inspired before he can inspire others.

We endeavored to develop a spirit of initiative by observing whether the candidate could anticipate contingencies and observe and perform tasks without specific orders or direction.

We stressed the fact that leadership does not depend upon physical courage alone, although it is a highly essential quality usually taken for granted. It is moral courage which is more important.

We gave him problems to test the keeness of his powers of observation so that he might develop the habit of perceiving, as differentiated from merely seeing or noticing, and select only that worthy of storing away for future use.

We tried to bring out evidence of constructive imagination, ingenuity, and resourcefulness, a realization of opportunities presented, and encouraged the trainee to create new ideas or to conceive new or better ways of doing things.

Particularly, we checked on how he handled his men, whether he was considerate or arbitrary, open- and receptive-minded or narrow-minded, firm or vacillating, wise or foolish, whether he could secure co-operation and develop teamwork.

We watched his ability to concentrate by giving the closest attention to his task or mission, and tested his accuracy and thoroughness in following a task through to its successful completion without leaving loose ends.

We tested his ability to organize a task by demonstrating a capacity to analyze, select essentials, and systematize by arrangement in logical and effective relationship.

We afforded every opportunity to demonstrate his adaptability by observing whether he made prompt and smooth change of plans, policies, or courses of action in meeting suddenly changing situations.

We tested his ability to instruct his group by conveying his ideas clearly, simply, succinctly and convincingly either orally, in writing, or by any other effective method.

CONCLUSION

I have touched upon many of the factors we considered in our effort to select and train prospective leaders. We found no simple yardstick or predictor which would enable us to select successful leaders from a cross-section group of candidates. Careful preselection, together with continuous and extended observation under suitable conditions of opportunity, encouragement, and environment appear to give promise of achieving some measure of success in training men for leadership.

I should like to repeat that we in the service feel that we have not found a complete or final solution to the problem of selecting and training leaders. We are convinced that there is no more vital or pressing problem facing our nation today, than how to find and train the junior leaders and executives, military and civilian, from whom the Eisenhowers, the Marshalls, the MacArthurs, as well as the Kellers, the Fairlesses, and the Wilsons of tomorrow must be selected. We hope to improve and refine our leadership selection and training procedures, and of course our experiences will always be available to American industry. We feel certain also that industry's profitable ideas and experiences will continue to be available to us, as they have been during the war period. If the further efforts to solve this problem of leadership training can be prosecuted by the Armed Forces and industry working as a mutually supporting team, I am confident that a worth-while and much to be hoped for solution will certainly be found.

NAVY TRAINING *for* LEADERSHIP

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NO organization can exist without leadership. That brief statement embodies the entire history of the development of society; for the letter and the law of progress from the beginning of human relationships is written in terms of action by the men who were "leaders of men."

The Navy cannot exist without organized leadership; an established system of personally controlling men. The system of control may be backed by education, laws, regulations, and customs. But laws, regulations, even formal academic instruction are only means to an end. Knowledge alone or confidence in the written word that enforces or upholds an action or a decision is not enough. Many people are found in all walks of life who know much but are not leaders—people who will never be able either to impart their knowledge to others or to influence others to action which accomplishes the results desired by the "knower."

THE UNIVERSITY AS A SOURCE OF POTENTIAL LEADERS

Probably the greatest single source of trained citizens with leadership potentialities in time of peace is the civilian university. Civilian universities are geared to educate students of various levels of background and intelligence according to their individual desires or preferences. This results in a single institution aiming at many different points of accomplishment, all of which require different levels of training and education. Under these circumstances, it is not desirable, or possible to produce a standardized product, as each graduate will eventually be entering his vocation in a different section of the country, performing dissimilar tasks; some in the professions and some in industry. From this educational process the competition of society, and the organizations or institutions of society, will produce some leaders and many "knowers."

TRAINING FOR COMBAT LEADERSHIP

The Navy, trained on the theory of the military chain of command, knows that under the uncertainties in action during wartime, each echelon of command must be capable automatically of assuming and carrying out the duties of the next higher echelon during the absence, through accident or casualty, of the superior during combat.

Proper naval education therefore must strive for standardized training of the individual for combat leadership. He must be prepared, regardless of his individually outstanding characteristics, to react with promptness and decision, instinctively, in the same relative pattern as the disabled superior he is replacing. Capacity for teamwork, rather than individual action—however brilliant—which has not considered the relationship of all the component parts, is the primary objective of proper naval training.

The greatest problem of successful naval education and training, and particularly the training of junior officers, is to secure the highest development of the teamwork concept without submerging the individual's potential ability to think for himself or militating against his contributing to the emergence and development of new concepts and instrumentalities in his chosen profession. Training for leadership in the Navy can be translated into the following objectives:

1 The trainee must be made to feel he belongs in the Navy.
2 The trainee must be made able to assume responsibility.
3 The trainee must be instilled with the desire to become a leader in the true sense of the term.
4 The trainee must have real practice in solving practical leadership problems.

A glance at the four objectives will reveal that two types of training approaches are necessary: (1) It will be advisable to consider the problem of developing proper attitudes; a liking for the Navy and respect for Navy life; a willingness to assume responsibility; a desire to be a leader. (2) The trainee will have to be given actual experience or simulated actual experiences in solving leadership situations.

INDOCTRINATING THE STUDENT LEADER

It is no easy task to indoctrinate a student leader into the Navy in such a way that he feels as natural in it as he did in his civilian setting. It can never be done merely by calling the floor a deck, the walls bulkheads, or by memorizing a few hundred Navy terms. It goes far deeper than that. It grows only from a thorough understanding of the reasons for the differences between civilian and Navy life. The changes that the pressure of danger make on social action must be thoroughly explored. The traditions of the Navy must be studied. The problems resulting from close living and working together must be considered in the light of their effect on rules governing

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Navy behavior. The future Navy leader must recognize the fact that he will never be accepted in that capacity unless he lives and acts the part of a real leader. The officer who is not indoctrinated with the Navy way of life is a foreigner in a strange country as far as leadership goes. Every activity in training must be handled as if it were aboard ship. Men must be treated as if they were already on duty in a naval capacity.

The Navy way of life makes it imperative that the Navy leader be willing and anxious to accept responsibility. This willingness may be fostered by examples. The "Message to Garcia" is a familiar sample; the lives of naval heroes are filled with others. Students may also be placed in a training environment where they are constantly expected to take responsibility. The one place not to "spoon-feed" the student is in the leadership class.

There are two common reasons why men are not willing to accept responsibility—laziness and inability to plan what is to be carried out. Every potential leader must be conditioned to hard work. There is a mistaken notion in the minds of many people that the higher one climbs in the leadership level the more leisure time he will have. This is contrary to the actual situation and leader-trainees should be given duties through the entire leader-training program that will necessitate working long hours under pressure and with the goal of accomplishment in the light of difficult conditions.

WHAT THE LEADER-TRAINEE MUST LEARN

Ability to plan is one of the most important abilities of the leader and requires careful and continuous development. In addition to lectures, discussions, assigned reading, and analysis of well-planned activities, problems of planning, which involve the facts of a situation, should be constantly given trainees to provide practice in skills necessary to plan quickly and effectively.

The desire to be a leader may be inspired by discussion, observations, and reading. Stimulation of this desire is one of the first functions of leadership training. The desire must not be built up merely because of the glamour and prestige of leadership but because of the service the leader can perform, the possibility of developing men under him, the utilization of his talents, and the satisfaction of achievement.

The leader, too, learns by doing. He must have an opportunity to apply what he learns. The student leader must have the equivalent of a shop period or laboratory. In a leadership course, the use of practical problems utilizing intelligent leadership techniques can provide this opportunity.

During his period of training it is essential that the prospective leader learn the habits of instant obedience to orders of his seniors in the chain of command, in order that, when he himself is in charge of others, he will realize the importance of and expect instant obedience to his orders from those under him. To bring full realization of this fact it is essential that he comprehend the fundamental difference between the civilian and the military. In both, but especially in civilian life, there may be times when it is proper to argue a point and debate an issue; but in the latter, it happens more often than not that orders must be given and carried out instantly. In a military organization unhesitating and immediate compliance with orders may mean the difference of many lives, including the leader's own.

THE LEADER MUST BE WORTHY OF HIS COMMAND

Because of this indisputable fact, it is absolutely necessary that everyone in position to command be worthy of that position, be trained in forethought and judgment, be known for honesty and the possession of a character that can and will meet the responsibilities which command must assume. The whole fabric of the naval establishment therefore is built on knowledge of and confidence in the integrity of the officers and men who make up its personnel. Particularly is this of vital moment in wartime. Assurance of the veracity and accuracy of the responses to his questions and the implicit knowledge that his orders will be carried out without equivocation or delay contribute in great measure to timely and correct decisions by the individual in command. Eventual success may well rest on the accuracy and completeness of the information he has received.

In the training and development of Navy leaders for the wartime period the philosophy of these objectives and the problems of their accomplishment have been vigorously applied to the training methods of specialist, indoctrination, and other Navy schools. The results have been inspiring, as well as successful.

HUMAN APPROACH *in* LEADERSHIP

By SAM A. LEWISOHN

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I RECALL with considerable pleasure the several occasions on which I gathered together at my home twenty years ago a distinguished group of engineering educators and industrialists, including Owen D. Young, Dean Dexter Kimball, Gerard Swope, General R. I. Rees, Elliott Smith, Dean A. A. Potter, Gano Dunn, Sumner Slichter, and Dean J. H. Willitts.

Our conclusion was that while young engineers understood the strains and stresses of metals, they did not understand the strains and stresses between human beings. The evidence was clear that the training given by our engineering schools at that time did not adequately equip men to handle the human problems involved in labor relations and staff relations, that is, so-called "human engineering." Industrialists found that men who came from such schools might be excellently prepared in technical subjects but woefully unprepared in the art of developing the human beings under them. All agreed that this lack of training in human problems was a serious inadequacy in their preparation for their future careers. For the first thing that is asked about an industrial executive is: "Can he handle labor relations?"

I have in mind particularly the case of a well-trained engineer in one of our outlying Latin-American properties, who was most competent technically but had to be removed for lack of qualities of leadership and ability to get along with other men. His place was taken by a man who instead of being a martinet was a diplomat and who was more human in his approach. The contrast in the morale of this particular organization under the successor management was most instructive. The second manager had a thorough understanding of the job of leadership and there was a dramatic increase in production.

Men might think that they would confine themselves to research work and therefore could afford to neglect developing

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Management Control of INDUSTRIAL ACCIDENTS

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IN general, the reasons for establishing a comprehensive safety program in any manufacturing plant are well known. In order to approach the problem concretely, the author has drawn upon the experiences of his company whose safety methods have proved to be successful in operation.

SAFETY REDUCES MANUFACTURING COSTS, BOOSTS MORALE, AND INCREASES PLANT EFFICIENCY

Primarily and basically all operating executives are interested in the control of costs, either direct or indirect, in the operation of their several departments or plants. A great many of us are liable to overlook the excessive costs which can accumulate to a company which has an unfavorable accident-experience record. Accidents in themselves are expensive, but when it is considered that there is probably a ratio of 4 to 1 in the over-all-cost picture of any direct accident cost, it can be seen that there is a possibility for a large amount of hidden and undetected auxiliary costs which accompany any accident. These costs can be attributed to the actual injury to the worker, to the loss of time required to break in a replacement if it is a serious accident, to the loss of time through curiosity and employee interest in the department in which the accident occurs, to the physical damage to property and equipment, and, if the accident occurs in continuous-process manufacture, to the loss of effort in other dependent operations.

Furthermore, a comprehensive safety program contributes to the morale of the worker in a number of specific ways. The philosophy is brought home to the worker that the company does not consider him a mere link in the productive chain, but he is made to realize that it has a definite human interest in the welfare of the individual employee. An employee who realizes that the company for which he works is doing not only what is required by law but, in addition, is making a sincere all-out effort for his individual safety, cannot help but carry that thought into the other relations he may have with the company and its policies. It is felt that regard for the safety of his employees is one of the paramount considerations that any employer should show toward his employees.

We believe that there is a definite relationship between the accident experience of the plant and the quality of the work performed. Usually it will be found that the best way to perform a job is also the safest way, because of its influence on the operating procedures in tooling provided to do that particular job. Every accident which can be eliminated, allowing us to keep a qualified, trained, and skilled operator on his particular job, means that we have that much less likelihood of losing quality performance through the breaking-in of inexperienced and unqualified operators.

Quantity of output can be maintained at a higher level, in an accident-free atmosphere within any department, than is indicated by the loss which does occur at the time of an accident. If the process is mutually dependent on a number of operators working closely in conjunction with each other there is a period of acceleration which is required to bring the unit back into cohesion which usually extends considerably beyond the actual time lost by the accident. In independently performed operations there is a natural distraction induced in the minds of the other workers out of concern for their unfortunate fellow worker, and speculation as to their own individual welfare. Division of thought from the job at hand never contributes to increased performance.

SAFETY A FUNCTION OF FACTORY MANAGEMENT

Primarily, safety must be recognized as an important phase of factory management. It is believed essential that the safety department be established as a staff department, within the direct operating organization, with recommendations to and instructions from top operating management. It must be completely objective in its approach to the problem so that operating management will not be influenced by employer prejudice and possible erroneous assumption of fact.

The key individual in a successful accident-control program must of necessity be the safety manager or safety director. Whichever term may be used, his particular qualifications should include the following specific attributes:

Fundamentally, he must be sold on the value of safety work for its own results, and the responsibility should not be delegated to an individual who may include safety as one of many other functions. It is believed preferable that this individual have a background in engineering rather than in the liberal arts, because of the approach to a problem which engineering training insures. Many of his problems and many of his decisions and recommendations will require engineering analytical work. In addition, because of his contacts with the personnel of the plant, he must have the faculty of selling his ideas successfully to the individuals with whom he has contact.

In order to accomplish the aims of a safety program, he will have to use much creative thought, similar to that required by advertising and sales-promotion companies, and he must be prepared to carry the thought from its inception to the actual accomplishment at the point of operation. He must be vitally interested in the welfare of his fellow employees and at times may have to assume the position of being prejudiced in their favor, in cases in which there is no clear-cut line of demarcation. He must be capable of analyzing statistics and trends of the conditions which are revealed to him through his reporting system, in order to advise management of actions which might well be taken in view of changing conditions. Technically, he must be prepared with a thorough knowledge of compensation laws, procedures, and interpretations of insurance-company operations, in order to assure the company of adequate protection in case of need. A requirement which is frequently useful, but not always necessary, is that of job analysis. He should be familiar with the physical requirements of the various types of operations within the plant, in order to insure or advise against

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improper placement of workers with latent possibilities of accidents.

SETUP FOR A SAFETY ORGANIZATION

In our company we have established various levels of organization from personnel in the Manufacturing Division with certain broad duties and functions. Committees are made up of members who have, as an additional duty to their supervisory functions, the responsibility for passing and checking on the safety conditions of the entire plant.

The General Safety Committee meets quarterly or as often as necessary to act on policy development. Its members are as follows: Vice-president in charge of manufacturing, chairman; general plant superintendent; four plant superintendents; manager of buildings and grounds; safety engineer, secretary.

The committee passes upon reports and minutes of the Foreman's Safety Committees. Other functions include the following:

1 Development of standards for safety equipment.
2 Safety standards for the design and purchase of new equipment.
3 Development of standard operating safety practices, including safety rules and systems of reward or penalty. Consideration of any question of safety policy, including the decision of what to do with any specific problem that arises.
4 Accident-cause classifications for statistical purposes.
5 To review all material that may be referred for action by unit safety committees.
6 The General Safety Committee is the approving body on all matters of policy, and designates authority to the unit safety committee.

The Foreman's Safety Committees meet monthly on both shifts in each plant. The purpose of these meetings is primarily educational, although authorization on practically all recommendations can be given by members present. Members are as follows: Plant superintendent, chairman; union representative,[1] Workman's Inspection Committee chairman; plant engineer; labor-relation's representative; four factory foremen;[1] one nonfactory department head;[1] safety engineer, secretary.

In addition to the educational benefits derived from the discussions in these meetings, the committee carries out the following functions:

1 Acts as a clearing house for all safety ideas and activities, following through on them until finally disposed.
2 Reviews investigation of all accidents and is responsible for preventative action.
3 Supervises contests or competitions.
4 Assists in deciding questions on applied safety standards.
5 Furnishes the General Safety Committee with the minutes of its meetings and other detail pertinent reports, including recommendations for further action.

Workman's Safety Inspection Committees. These committees are made up of three shop stewards in each of our four plants on the first shift. These men are appointed by the safety engineer from a list provided by the union president. Each month one member is dropped and a new member is appointed, leaving always two experienced men with the new man to make the inspection. When the member is dropped, he has done his turn of three monthly inspections and now is given the opportunity to sit in with management to make up the membership of the monthly Foreman's Safety Committee. Here he has the opportunity to discuss with management many of the unsafe conditions and practices he observed on his tour of inspection. The knowledge that recommendations are being carried out, and perhaps some that he recommended are impractical, is of educational benefit to him. This knowledge prevents many grievances on unsafe conditions, which to the shop steward would be serious, especially if he felt that management was doing nothing about the recommendations. These men are given distinguishing badges which they take pride in wearing. The act of doing an inspection job gives them great satisfaction, in that they feel they are aiding in safeguarding their fellow workers. Energies, otherwise wasted, are put to good use.

Departmental Safety Inspector. Each foreman or department head, on both shifts, has one safety inspector appointed by him who is responsible to him for all unsafe conditions or unsafe practices observed during his regular duties in his department (a general helper, rather than a machine operator, is preferred). Thus many unsafe conditions of the plant and equipment, and unsafe practices of the employees can be corrected immediately without recourse to discussions in regular safety meetings.

Safety Department Inspection. Safety engineers inspect each plant on both shifts not less than once a week. Recommendations on both unsafe working conditions and employee practices are compiled. Together with those of the Workman's Inspection Committees, War Department, Labor Department etc., they are submitted to the monthly Foreman's Safety Committee meetings for discussion and possible corrective action.

PHYSICAL ARRANGEMENT OF PLANT

In order to achieve the maximum result it is always desirable that the physical establishment of the plant be as ideal as possible. It is realized that many companies have had to compromise in a number of instances in their physical setup, and the requirements which are believed desirable may not be possible of fulfillment. Primarily, the arrangement of the plant should be such that the responsibility for the physical equipment is vested in one person or in one department, under a competent plant engineer. With responsibility for the plant arrangement vested in this department, which reports to the operating management, the influence of the safety department, for safety considerations, is believed to be vastly augmented.

All rearrangements of the plant are reviewed by the safety department, prior to the performance of any work, for criticism and recommendations which may be revealed by its study. Conditions which may create hazards are thus avoided, and excessive costs are curtailed, either by preventing the installation of a hazard requiring rearrangement, or by eliminating a possible cause for accidents.

Naturally the plant must have adequate ventilation, light, and heat for the area in which it operates and the type of work which is performed, but one of the most important elements which must be considered is that of efficient housekeeping. The plant which is allowed to accumulate debris creates a careless attitude on the part of the employees, which affects not only their productive actions but the manner in which they perform their jobs. Proper and efficient housekeeping of any plant is believed to be a prime requisite.

COMPREHENSIVE FIRST-AID FACILITIES MUST BE PROVIDED

In order properly to care for accidents after they have taken place, and after as much attention as possible has been devoted to their elimination, adequate first-aid facilities should be provided. In larger plants it is believed that a doctor should be in attendance or available for call, upon very short notice. The heart of the first-aid system must be the industrial nurses, who by their close contact and immediate availability are prepared to take care of emergencies as they arise. These medical personnel must be provided with adequate first-aid

[1] Rotated monthly for educational purposes.

equipment, suitable to caring for the emergencies that are probable. Hospitals are not believed required in moderately sized plants in metropolitan areas, but adequate means must be available for the transportation of injured workers. Disaster units which were organized during the war years, are not believed to be essential except in peculiarly hazardous industries.

Whether caused by accident or illness, all visits of employees to first-aid stations are controlled by the issuance of first-aid passes by the individual's supervisor, unless the accident or the condition of the employee is too serious to allow for the loss of time involved. These forms are effective controls on the loss of time of the employee, and in addition require that the supervisor immediately indicate what took place if an accident occurred. This form then becomes a minor accident report and enables the compilation of information relative to what occurred immediately after the occurrence when the information is fresh in the minds of those directly concerned. It also enables management to separate concretely the occupational from the nonoccupational treatments required in the medical department.

OUTSIDE AUTHORITIES CONSULTED ON PLANT CONDITIONS

In addition to the numerous inspections carried out by the safety organization within the plant, great use is made of outside authorities for technical investigations. If questions arise relative to conditions dealing particularly with industrial hygiene or of occupational-disease hazards, competent unbiased technicians are engaged to survey the question and to report on their findings. The fact that the findings are rendered by independent agencies makes their acceptance by the employees much easier to obtain. Also, if the need should arise in the future, because of a claim for disability involving a particular phase or area, the company is in a position to defend an improper claim properly. If the report indicates that a hazard exists, immediate steps can be taken for its removal.

Since the maintenance of complete medical records is a requirement of the State of New York, an added tool is available to the company in maintaining a close watch on those individuals who are organically weak or who are so careless that they have a poor accident record. As soon as the medical department has determined that an employee has an ailment or possible disability which may lead to a potential claim, his supervisor is immediately notified of the limitation so that he may guide himself in his work assignment to prevent further aggravation of the pre-existing disability. All employees are given pre-employment physical examinations to screen out those who may prove to be severe risks in certain types of work. With the tremendous increase in employment requirements during the war period, standards which had previously been required needed to be relaxed. This has brought a considerable number of employees into our plants who have had to be assigned to specific, less hazardous work, but through proper placement, under the advice of the medical and safety departments, the potential liability has not developed into an actuality as yet.

CODE OF SAFETY RULES NOT NECESSARY

We have not found it necessary to promulgate and strictly enforce a large number of safety rules. Certain specific isolated practices are forbidden and enforced but the entire program has been built up on the basis of safety consciousness. The supervisors are given safety training courses approximately once each 6 months, the average course being for about 4 or 5 hours. We have tried to instill the thought of working safely in all of the operations being performed within the plant, rather than to single out a large number of isolated cases and emphasize them. Our object has been to cultivate in the minds of our supervisors the thought that they are responsible for their people all of the time and not just when they are doing work which is particularly hazardous.

In order to develop and retain interest on the part of the supervisors during this training, each individual is awarded a distinctive certificate at the conclusion of his course. By concentrating our training in the supervisory group we have been able to expand the normal capacity of our safety department by having in effect a junior safety engineer present whenever we have a supervisor directing the working force. In addition, those members of the safety committees who have not been in the safety classes receive training at each of the committee meetings, when specific problems which are causing difficulties are discussed, and the recommended method of correction is outlined by the safety engineer.

GENERAL SAFETY POLICIES

To guide the general safety program certain policies are in effect which promote and reinforce the work being done.

We believe that the company is the gainer by accepting and treating a large member of minor nonoccupational cases. This policy has been carried to such a point that the ratio of cost of nonoccupational treatment to occupational treatment is close to one-to-one. By treating colds and minor ailments we feel that we have definitely lowered the absentee rate for nonoccupational cases, and as a result have a healthier working force despite the long period of time spent at long hours of work.

We accept the precept that man is fragile and must be treated with greater care than our most costly and delicate equipment. Our employees are not considered as links in the chain of production, but are treated and considered by their supervisors in their work assignments exactly as if they were close relatives, and job layouts are made on that basis. With the largely expanded working force that we have had, a sincere attempt is made to continue the human touch which is usually so much more prevalent in a small organization. This feeling has been fostered by top management and has been developed by an alert personnel department.

The responsibility for safe, accurate, and quantity production has been localized in one division so that there is an elimination of the possibility of "passing the buck," in so far as the safe and efficient operation of the plant is concerned. No organizational barriers are erected from the time a hazard or difficulty is uncovered until steps are taken by the plant engineering group in physical arrangements, and the operating group in manufacturing, to correct it immediately. Since all departments concerned report to one office, the accomplishment of the task can be much more easily attained.

We have taken the position that plant safety, to be most successful, must be sold and not categorically ordered. Rather than compulsion, our people are influenced along the line of safe practices and habits, using all the ramifications of an advertising campaign.

We believe that the people who are closest to the problem should be acquainted with the results. Consequently, condensed safety reports are submitted to all departmental supervisors at least once each month advising them of the previous month's experience.

Competition has been accepted as a tool with which to work. We have entered all contests for which we were eligible in order to develop that spirit of competition.

RESULTS ACHIEVED

As a brief résumé of the results of this effort, the following figures will emphasize the value of a comprehensive safety program. The comparison in performance will be made for the year 1941 when the safety program was inaugurated and the

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ELECTRICAL STANDARDS *for* MACHINE TOOLS

By R. H. CLARK

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GENERALLY speaking, it is the function of an electrical engineer on the design staff of a machine-tool manufacturer to find ways of employing existing electrical equipment advantageously for the improvement of new machine designs. He sometimes has the problem of originating such equipment.

That is to say, as progress is made in electronics, variable-speed drives, electromagnetic relay systems, and the like, it is up to him to know the scope of their uses, to recommend their advantages, and engineer their incorporation in new machine-tool designs.

In this, the thinking of the electrical engineer must be closely aligned with that of the mechanical designer in order that two things may be accomplished: (1) The application of such electrical equipment as he selects must be engineered to achieve the functional purpose of the new design. (2) At the same time, the application must meet the structural limitations of the machine itself.

Certain types of machine tools that fall into the category of milling machines obviously present a lesser problem, for instance, than do such types as turret lathes, and the like. Planers, by their mechanical structure, practically necessitate a separation between themselves and such electrical equipment as may be used with them, whereas automatic machines, from the largest to the smallest, obviously call for integrated application.

In view of such basic problems of engineering and considering the wealth of new electrical developments that have become available, it is only through the formulation of minimum standards, begun some years ago, that the electrical engineer finds himself sufficiently free to function in collaboration with the machine-tool designer.

In fields such as that of the milling machine, for instance, the potentialities of increased power and speed are of current interest. This poses very serious problems of where to place the larger motor and control, that they do not interfere with operation of the machine and yet are accessible for maintenance and protected from damage. Furthermore, because of the reduced machining time, full advantage must be taken of the possibilities of reducing machine-handling time by the use of additional automatic electrical controls.

As we seek greater advantages from the more complicated machines, particularly those of the automatic type, the electrical engineer is relied upon to a greater extent to point the way by which such systems of controls can best be utilized.

In this, the reduction of setup time and simplicity of repetitive operation inevitably become the deciding factors. Often the electrical engineer is called upon to devise and present, in summary form, both the advantages and disadvantages that will result from the incorporation of any such possible system in the design under consideration.

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SELECTING AUTOMATIC CONTROLS

In conference with the mechanical designer and his associated specialists in other fields, the summarized presentation then will be weighed against the potentialities of mechanical or hydraulic systems aimed at accomplishing the same result.

Out of the revisions of plans and engineering a decision is reached by the chief designer to employ, let us say, such a system of automatic controls as that which has become an integral part of the "Electro-Cycle" turret lathes of the author's company.

This system was selected as the best means of transferring to the machine many functions previously performed by a skilled operator. These electrically controlled automatic functions include the following:

1 Spindle speed change.
2 Start and stop of spindle.
3 Spindle reverse to control depth of tap.
4 Preselection of spindle direction for right-hand or left-hand tap.
5 Stopping of spindle at predetermined position for loading of work.

In the design of a machine of this type, the first step is to establish performance specifications and then decide the best means for accomplishing the desired performance.

The electrical engineer then draws an elementary or functional electrical diagram and determines what apparatus is required. This information is turned over to the mechanical designer together with an outline of the space required and suggested means for operating limit switches and other apparatus actuated by the machine elements.

From that point on, the mechanical designer and electrical engineer must work in closest co-operation to achieve the best results. Many compromises on space and location of apparatus usually must be made in order to arrive at a workable design.

The final result of such procedure in the case of the Electro-Cycle turret lathe has been a machine of good appearance, excellent performance, and is easily maintained. More accurate parts can be made and at a rate 25 to 100 per cent faster than on similar machines now in use.

Since the mechanical designer is usually responsible for the ultimate success of the machine, he should insist that the electrical apparatus be selected and applied with the same care as used for mechanical parts. He may have the assistance of an electrical engineer in his own organization, or depend on engineering service from some other company. In any case, the electrical engineering must be expertly done and as an integral part of the over-all machine design, if the machine is to be entirely successful. By close co-operation of the mechanical and electrical designers, the many problems encountered can be satisfactorily worked out.

FIRST ISSUE OF MACHINE-TOOL ELECTRICAL STANDARDS

Mechanical and electrical designers working on machine

designs have been severely handicapped in the past through the lack of proper standards to guide them in their design work. The National Electrical Code was entirely inadequate, and other design standards were scattered through so many publications that they were not usable. These facts were recognized by the machine-tool industry and an Electrical Committee was appointed to prepare minimum standards and application information for the guidance of mechanical and electrical designers of machine tools. The first issue of the Machine Tool Electrical Standards, A.S.A. C-74, appeared in June, 1942, as a War Emergency Standard. In July, 1942, WPB made the use of these standards mandatory for the machine-tool builders and the users, to facilitate the mass production of machine tools during the war. This action of WPB eliminated the many and varied special requirements of certain large users, but it did not convince these users that their special requirements should not be met on postwar machines.

Rather than go back to the prewar conditions of many individual user's electrical specifications, with the resulting confusion and high manufacturing costs, the present Electrical Committee undertook to revise the C-74 Standards more nearly to conform with the large users' requirements and to serve as a more complete guide for the machine designers. For the past two years this work has been carried on with the co-operation of a Joint Industry Committee representing the large users of machine tools. This committee represents most of the large automobile manufacturers and many other industries in the Detroit area. At the same time, the Joint Industry Committee has standardized the special electrical requirements for machine tools used in mass-production industries and eliminated most, if not all, of the twenty-five sets of users' specifications previously being applied.

AGREEMENT SOUGHT WITH AUTOMOTIVE STANDARDS

The main problem of the two committees working together has been to bring the C-74 Standards and the Automotive Standards into agreement in so far as possible. This has been done to the extent that there are now only twelve points of disagreement in the more than 100 paragraphs included in the standards.

For the convenience of the members of the National Machine Tool Builders' Association and others, the publication "Machine Tool Electrical Standards" for general industry includes also, those paragraphs of the Automotive Standards which are not in agreement. In due course it is expected that the General Industry Standards, with minor modifications, will become the revised A.S.A. C-74 Standards, since they have now been approved by the membership and board of directors of the association.

The General Industry Standards contain some "Recommended Practices," which are considered good engineering practice, but which would create undue hardship on some builders if made mandatory at this time.

GENERAL INDUSTRY STANDARDS

The following is an outline of the major points covered by the General Industry Standards, with mention of the Automotive Standards where they are in disagreement:

General. This section covers the responsibility of the user to furnish the necessary information to the builder, and also the responsibility of the builder to provide the user with complete specifications of the electrical equipment to be used on machines, when required.

Wiring Diagrams. The machine-tool builder is instructed as to what type of diagram is to be supplied and how many copies are to be furnished to the user. The builder is required, further, to use American Standard symbols and to provide an elementary diagram and schematic sequence of machine operations for all but the simplest apparatus.

On large machines requiring a special foundation, size, purpose, and location of the conduit and incoming lines must be shown on a print specially prepared for the purpose.

Controls. All controls, whether purchased or manufactured by the machine-tool builder, shall be American Standard for such equipment.

The Automotive Standard limits the minimum motor starter to N.E.M.A. size 1 starter for double protection against any electrical or mechanical failure.

For many years the disconnect switch, or circuit breaker, for the branch circuit supplying power to the machine tool was considered the responsibility of the user. This apparatus now becomes the responsibility of the machine-tool builder on all but small bench-type machines powered by a single motor rated 2 hp or less. A recommended practice states that the disconnect switch, or circuit breaker, should be made a part of the control panel and interlocked with the control enclosure door.

Overload protection for each motor shall be supplied, except in the case of short-time-rated motors. Furthermore, undervoltage protection shall be provided for all the motors which might cause damage or injury if they should start after interruption and return of power. Proper interlocking of the control is also specified to insure proper functioning of the machine.

Through the work of the original Electrical Committee of the National Machine Tool Builders' Association, the National Electric Code was revised to permit grouping all of the motors and controls for one machine under the protection of one branch-circuit overcurrent device. The limitation of approximately 25 hp for the total machine horsepower was set at that time as a safe figure, and certain construction features for the enclosures for the control equipment were required to minimize any fire or injury hazard in case of a short circuit.

In view of the greatly increased horsepower being used on present-day machine tools, it is now believed that the limitation should be raised to approximately 50 hp per machine, and that certain changes be made in the specifications of the enclosure for added protection to the control equipment. Final approval for such changes rests with the National Electric Code authorities, and the necessary steps are now being taken to determine whether the larger ratings can be safely used.

A subdivision under this heading covers in some detail the construction and location of the enclosure for the control and recommends that all control devices for any one machine be mounted in one enclosure instead of several enclosures at different locations on the machine.

AUTOMOTIVE STANDARDS VERSUS GENERAL INDUSTRY STANDARDS

The Automotive Standards differ from the General Industry Standards in that further precautions are required to give added protection to the control equipment. The Automotive Standards specify that all enclosures for controls shall have hinged covers which swing horizontally and shall be held closed with screws or bolts which require the use of a tool such as a screw driver or wrench to remove. The General Industry Standards agree except on the means for holding the door closed.

As a recommended practice covering the mounting of control equipment, the General Industry Standards specify that all terminals and parts of devices normally serviced or inspected on control equipment should be mounted not less than 8 in. above the floor line of the machine. The width and height of the control panel should be at least 1 in. less than the corresponding width and height of the door opening, and the depth of the control compartment should be a minimum consistent with

the maximum depth of the devices plus the required electrical clearances. Furthermore, no portion of the machine immediately above the door opening and less than 6 ft from the floor should project more than 6 in. beyond the door frame.

The Automotive Standards require that when the control enclosure is mounted on the machine, the bottom of the enclosure shall be 2 ft or more above the floor. When separately mounted, the user will mount the enclosure at the desired height.

The location and type of limit switches and push-button stations are specified to insure trouble-free operation and promote safety in the operation of the machine.

In the construction of control panels, it is required that on all front-connected devices each device shall be removable from the front of the panel without the necessity of removing the panel from the enclosure. The method of identifying the wires and the use of terminal boards are covered for ease in servicing the equipment.

Proper marking of coils, the rating of motor starters for jogging or inching duty, and the number of poles for disconnect switches and motor starters are covered by the section on the type of control.

Motors. The General Industry Standards require that the purchaser shall specify the type of motor enclosure desired, and that all alternating-current motors, $^1/_4$ hp and larger, should be operated on polyphase power. The type of motor, that is, whether special or standard, is not limited.

The Automotive Standards require that all motors shall be totally enclosed, or totally enclosed fan-cooled. The use of special motors, such as flange-mounted, shaftless, geared, or National Electric Manufacturers' Association rerated frame, or other special motors, must be approved in writing by the user before they can be furnished on the machine by the builder.

The General Industry Standards require only that in the mounting of the motor, the motor hold-down bolts shall be easily removed and replaced and the conduit boxes easily reached; whereas, the Automotive Standards require space for a motor of the next larger size, if motors are mounted inside the machine tool. If these conditions cannot be met by the builder it is necessary for him to furnish a motor mounted outside of the machine and to provide space for a motor one size larger than the maximum horsepower recommended by the machine-tool builder.

Both standards are in agreement that all motor compartments must be clean, dry, and adequately vented direct to the exterior of the machine, and that protection against dirt and chips must be adequate to prevent trouble from this source. If a conduit or pipe is run into the motor compartment from a dirty section of the machine, all clearances around the conduit or pipe must be sealed.

It is further required that all motor name plates must be visible, or a plate with duplicate information shall be provided where it can readily be seen. Removal of the name plate from the motor is not permissible.

Wiring. Current capacities of wires external to the control panels shall be furnished in accordance with the National Electric code, except that to meet the Automotive Standards, this wiring shall be large enough for the next-larger-horsepower motor.

No splices are permitted in control wiring and all splices in power wiring must be covered with varnished cambric, or oil-resisting synthetic tape, and given an oil-resisting treatment.

The use of an oilproof insulating compound on wires is required where subject to oil, coolant, moisture, or vapor, and for a 110-volt circuit an insulation of $^2/_{64}$ in. thickness may be used. The Automotive Standard requires that a minimum thickness of $^3/_{64}$-in. insulation shall be used at all voltages and this provision has been adopted as a recommended practice in the General Industry Standard.

A recommended color-coding scheme for wiring is specified to agree with a proposed color-coding scheme of the electrical industry.

Current at 110 volts on all control circuits on alternating-current-powered machine tools is recommended, and for the automotive industry this is mandatory. The means of obtaining and the proper protection of these circuits are specified.

Under the subject of "Conduit and Raceways," it is required that all stationary-machine wiring shall be totally enclosed in heavy wall conduit, conduit fittings, and junction boxes, or sheet-metal boxes. General-purpose flexible metal conduit may be used where necessary to employ flexible connections for small or infrequent movements, provided that it is not subjected to oil or moisture. Wiring connections to continuously moving parts of a machine shall be in an approved-type, oil-resisting, extra-flexible, nonmetallic covered cable, or a liquidtight flexible conduit with extra-flexible conductors. Compartments or raceways within the column or base of a machine may be used to enclose wiring, provided that such compartments or raceways are isolated from coolant and oil reservoirs, are entirely enclosed, and conform with the N.E. Code. A clearance of 1 in. must be provided between such conductors and any moving mechanical parts, or suitable barriers must be provided. Junction boxes shall not have extra knockouts, and shall be provided with gasketed covers to make them oiltight and watertight.

The Automotive Standards agree with these specifications, with the exception that no general-purpose, flexible metal conduit may be used for any purpose; liquidtight conduit being required where small or infrequent movement of the apparatus is involved.

Grounding. Both standards require that all control cabinets, motors, metal conduits, control stations, and other devices, where there is a possibility of contact with current-carrying parts, shall be grounded. This grounding may be made by attaching the device to the machine tool with bolts or other approved means, if all of the paint and dirt are removed from the joint. It is the responsibility of the user to ground magnetic control equipment not attached to the machine and to ground the machine.

A provision for exposed grounded control circuits of 24 volts or less is made to permit certain gaging operations, but only where a complete description of the circuit and the reason for its application are given the user and his approval obtained.

The General Industry Standards require that where an auxiliary device must be removed under certain operating conditions, it may be connected through a plug and receptacle, or a junction box provided with a terminal board, if a grounding connection is included.

If a plug and receptacle are used on a machine tool, they must be of the locking type to prevent accidental disconnections, and they shall be provided with a gasket to prevent the entrance of oil or moisture when in operating position, and means provided to effectively seal the receptacle whenever the plug is removed.

Limit switches located in various places on the machine tool shall be identified with the same markings used to identify them on the wiring diagram to facilitate servicing. If any device is removed from its enclosure it is required that a name plate be put on such device to identify it adequately.

Copies of the Machine Tool Electrical Standards for General Industry, including the Automotive Standards, may be secured from the National Machine Tool Builders' Association, Cleve-

(*Continued on page 453*)

Postwar Plans for
SAFETY STANDARDIZATION

By CYRIL AINSWORTH

ASSISTANT SECRETARY, AMERICAN STANDARDS ASSOCIATION, NEW YORK, N. Y.

THE American Society of Mechanical Engineers has been a leader in the development of standards for many years. Safety standards have been an important part of its program. The A.S.M.E. Boiler Code is probably the best known and one of the most important safety standards ever developed. Its first edition was published in 1916, and all the legal requirements in effect throughout the country in this field are based upon this code. The A.S.M.E. has sponsored and led the development of the Safety Code for Elevators, Dumbwaiters, and Escalators; the Safety Code for Cranes, Derricks, and Hoists; the Safety Code for Jacks; the Safety Code for Compressed-Air Machinery; and the Safety Code for Mechanical Power-Transmission Apparatus. In the development of some of these standards it has had the assistance of other national organizations. All of these have been approved as American Standards. Others are in process of development.

This leadership and service to industry and government need to be brought to the attention not only of the members of the Society but to the country at large. This leadership by one of our great engineering societies emphasizes the importance of standardization and accident prevention and the relation of one to the other.

STANDARDS OF EVERYDAY IMPORTANCE

Safety standards coupled with other standards very closely affect our everyday living, and we should more fully appreciate this relationship.

The following cycle is presented to emphasize the importance of standards in our economic, social, and industrial life:

On arising in the morning, if you have to get up early, it is still dark at this time of the year. You therefore throw a switch to turn on the light. The switch, wiring, lighting fixtures, and other parts of the lighting system have been installed in accordance with the National Electrical Code, an American Standard. The wire used in the system conforms to American Standard specifications. The water for your bath and shave comes from a water system equipped with fittings and valves which are threaded, constructed, and installed in accordance with the requirements of American Standards. You put on clothes, the fabrics of which have been tested according to American Standards and you don linen laundered on machinery protected according to American safety standard requirements. For breakfast your coffee is made on a gas stove labeled to show that its construction and performance conform to the approved standard requirements for gas stoves and the food you eat is taken from a refrigerator tested according to the American Standard method.

In going to work if you drive or use a bus, you ride in a car inspected in accordance with American Standard inspection requirements. The windshield and other windows are constructed of safety glass made to conform to standard specifications. You or the bus driver observes the traffic signs and signals installed along the streets and highways, which are all constructed and installed in accordance with American Standard specifications. On reaching your place of business, you enter the building through doors which swing in the direction prescribed by standards. To reach the proper floor you go to your office by means of an elevator which has been constructed, installed, and inspected in accordance with American safety standards. The guarding of machinery in your plants, the lighting, the sanitation, the direction signs, the fire and exit protection, the exhaust ventilation, and many other items designed for your protection and comfort are all in accordance with the best known practice as set forth in American Standards.

When business is over for the day, you return home with American Standards exerting their influence as they did when you went to work. Coming in from the cold air you find your home heated with heating boilers constructed according to the A.S.M.E. Boiler Code. Finally, the picture can be carried one step further and, assuming that standards now under development are completed, you will go to sleep on mattresses constructed, from a health point of view, in accordance with these future standards.

Such a picture of the relationship of standards to daily activity indicates that the best safety-engineering talent available has been brought together for the purpose of assembling in the most suitable form those technical facts upon which all agree in order that you, your families, your friends, and neighbors can live happily and as free as possible from the dangers to life and health which our complex society produces. That is what safety standardization is all about.

These standards, and others developed by this Society and other organizations under the procedures of the American Standards Association, form the best collection of technical data that has ever been assembled. The subject is being discussed at this time to emphasize this fact and to remind the reader that he can solve his safety-engineering problems the standard way.

SAFETY STANDARDS AND ACCIDENT CONTROL

It is appropriate that we discuss the importance of safety standardization because safety standards provide an effective tool for managerial control of accidents.

Mr. Howard Coonley, chairman of the Board of the Walworth Company, in a recent article[1] stated that the advantages which can be reaped from an extensive use of standards could be summed up in the phrase "reducing things to simple routine." Standardization, Mr. Coonley stated, cuts down the pressure on executives from top to bottom of the organization, releasing them from the necessity of making many minor decisions. Standardization is a major key to administration.

Contributed by the Management Division and the Committee of Safety and presented at the Annual Meeting, New York, N. Y., Nov. 26–29, 1945, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[1] "Standards—Effective Tool for Managerial Control," *Industrial Standardization* (official publication of the American Standards Association), June, 1939.

Accident prevention as one phase of managerial control is no exception to these thoughts as expressed by Mr. Coonley. Many times I have had safety engineers say to me, "If I had only known that such a standard existed I could have saved a lot of time and more effectively determined the method of handling the situation."

What procedure would you use for inspecting your elevators? Would you follow the advice which Mr. Reppert recently gave the members of the Metropolitan Chapter of the American Society of Safety Engineers and use the American Standard Practice for the Inspection of Elevators and the American Standard Elevator Code?

If you have to buy a supply of safety shoes, would you study the protective features of the shoes demonstrated to you by the salesman? Would you know what tests to apply to determine the resistance to blows which the shoes would sustain? How would you judge the quality of the product?

These and many other questions have been presented to safety engineers and by safety engineers to themselves. The standard specifications prepared jointly by manufacturers, safety engineers, governmental officials, and others provide the answers to all these questions. Standards for purchasing safety equipment provide effective managerial controls. Decisions are reached, quality is assured, costs are lowered, and most important of all, accidents are prevented.

Safety standards are vital to an efficient accident-prevention program. If you haven't been using standards in your work, start now.

FUTURE SAFETY STANDARDIZATION EFFORTS

So much for the importance of safety standardization. What can we expect in the way of service from future safety standardization work?

The breadth of coverage of the safety standards which have been made available during the past 25 years is great, but the field of usefulness is not complete by any means.

How do you buy your safety equipment? Do you use the trial-and-error method? Do you depend upon the information given by the salesman for the equipment manufacturer? Do you accept whatever your purchasing agent buys for you? Do you buy on specifications containing performance requirements designed to insure that the equipment will perform the functions for which it is intended? I am sorry to say that the last question, which prescribes the efficient method for buying safety equipment, must be answered in the negative. The reason is a simple one. Only a few such specifications have been prepared. Mention has already been made of the specifications for safety shoes. The American Standard Safety Code for Head and Eye Protection does contain some specifications for goggles, respirators, and other personal protective equipment. The Federal Specification Committee, the Navy Department, the National Fire Protection Association and a few industrial and commercial organizations have done some work in this field, but generally speaking it is untouched.

Fortunately, it appears safe to predict that postwar standardization programs will include extensive work of this type. It is inevitable that the safety engineer and management generally will apply the same purchasing techniques to safety equipment that it applies to other equipment and materials which it buys. Industry erects its buildings according to specifications, it purchases its coal, steel, lumber, machines, tools, and thousands of other items according to specifications. Yes, industry hires its employees by applying job specifications to the task.

If the use of purchase specifications has been found to be the efficient method for obtaining the things necessary to the conduct of a business, isn't it reasonable to assume that use of specifications for the purchase of safety equipment will increasingly be followed, thereby creating the demand for such specifications.

It would seem likely that manufacturers and distributors of safety equipment will demand that such specifications be prepared. Many of them are furnishing scientifically designed devices and materials that afford complete protection to wearer or user. They are forced, however, to compete with many other manufacturers who, particularly during the war period, have entered the safety-equipment field without sufficient experience as to the needs of industry and the best methods of designing devices which will give adequate protection against accident hazards. Specifications which place a floor on the quality of safety equipment and materials force such manufacturers to meet the specifications or stop operating. Thus the manufacturer who has put much time, effort, and money into research, who has employed well-trained salesmen to advise with industry, and who is sincerely endeavoring to provide the best possible service, would not be forced to compete with a manufacturer who places inefficient equipment on the market at lower cost and who can provide little or no service.

The manufacturer will also demand equipment specifications to bring relief from conflicting rules, regulations, and practices of regulatory bodies which have power to approve or disapprove the equipment used by the industries under their jurisdiction. While American Safety Standards have done much to unify the legal requirements of the country, it is still largely true that safety equipment acceptable to one legal jurisdiction may not be acceptable to another. This introduces production problems which should be solved by the preparation of performance requirements and methods of test acceptable to all concerned, and the use of which would provide an open market throughout the country.

We can then safely look to the application of the standardization technique to the thousand and one safety-equipment items used daily by industry in its accident-prevention work.

STANDARDS MUST KEEP PACE WITH NEW DEVELOPMENTS

From time to time the engineer or the scientist invents a new device, machine, or material which improves industrial processes, increases our comfort, or advances our standard of living. Many of these new devices or materials are hazardous in themselves or may become hazardous if incorrectly used. Electricity, for instance, is a hazardous commodity; but which one of us would advocate the discontinuance of the use of electricity? None of us would because we have learned how to use it correctly. The procedures governing the use of electricity have been written down in the form of safety standards. The National Electrical Code and the National Electrical Safety Code both approved as American Standards are the governing documents. Millions of kilowatts of electricity are used daily throughout the nation, and in proportion to the exposure, it is rare that an accident is reported.

This form of control of materials, commodities, devices, and machines will, I predict, be greatly expanded in the postwar world. A tremendous field is open for the use of the standardization technique to prescribe ways and means for the safe use and handling of the products of inventive genius and of industrial operations.

Even devices which have been designed to be used as safety devices may in themselves be hazardous and subject to standard control procedures. The x ray, for instance, which has come into such extended use during the war period as a piece of industrial safety equipment, can become a detriment instead of a boon to our progress, health, and comfort if its use is not properly controlled. The x ray is used to determine the soundness of castings, the workmanship of welds, the existence of foreign particles in foods, the proper location of inserts placed in

molded products, and in a hundred and one other ways. There is no question but that the x ray greatly aided in winning the war. Fifteen to twenty years from now we will know how effectively, from a health standpoint, industry used this invaluable equipment.

Standardization of the principles of control is being carried on now—in these early days of the postwar era. During the war a partial standardization program was completed through the development and publication by the American Standards Association of Part I of the Safety Code for The Industrial Use of X Rays, covering general protection. Five additional parts are being prepared. They cover Radium, Methods and Materials of Protection, Specifications for 400-Kv and Lower, X-Ray Protection for One- and Two-Million-Volt Installations, and Electrical Protection.

No better example exists of the way in which standardization is to be used in the future to insure that everyone can have the best possible technical information in regard to the use of special equipment and materials developed and invented by our scientists and engineers, than the standardization program in regard to the use of the x ray.

RESEARCH AS A BASIS FOR STANDARDS

What else can we expect in the postwar world in regard to safety standardization? Well, I think we can expect extensive research programs to be carried on in order to obtain fundamental information necessary to the construction of a sound standard. This statement does not indicate that research has not been carried on in the past. The research carried on by the committee in charge of the Safety Code for Elevators, Dumbwaiters, and Escalators is an excellent example of what has been done in the field of research. It is evident, however, from the work already under way that research will be depended upon in the future in a very extensive way for the facts upon which to build a standard.

The elevator committee conducted research at the National Bureau of Standards which resulted in the complete redesigning of elevator buffers. Not only did the research develop the facts around which to write into the elevator code the appropriate safety requirements in regard to buffers, but the manufacturers of this equipment learned the weaknesses in the designs which they had developed. Thus they were able to change the designs and improve the efficiency of their product.

Several research programs are now under way. These are simply the forerunners of what is to come.

The National Safety Council under the auspices of its Engineering Division, the American Society of Safety Engineers, is now endeavoring to obtain the facts in regard to the slipperiness of walkway surfaces and the methods of treating and maintaining floors and other surfaces so that the slipping hazard will be reduced to the minimum. It has been impossible to standardize the methods for removing such hazards because of the lack of fundamental information. This research program will develop the facts.

The council is also endeavoring through research to get complete information in regard to safety belts, particularly window cleaners' belts. While many of the safety precautions to be followed in window cleaning have been standardized, it has not been possible to prepare complete specifications for belts because of the lack of facts.

Another research program which the council is conducting relates to the use of plastics in safety equipment such as head and eye protection equipment. Plastics came into extensive use in this way during the war, and while a vast body of practical experience has been developed, we do not know all the answers by any means. When the research is completed it is expected that specifications in regard to this material will be incorporated in the American Standard Safety Code for Head and Eye Protection.

The committee in charge of the development of the Safety Code for the Industrial Use of X Rays to which reference has been made, is carrying on research to obtain data upon which to design protection for 1,000,000- and 2,000,000-volt installations. Such installations are beginning to be made, and a severe exposure of this type makes it necessary that every possible item of protection data be made available to users of this equipment. These technical data will be incorporated into the standard now under development.

These research programs illustrate that we have passed from the adolescent stage of codification of personal opinion to the adult stage of codification of provable facts. Technical research in the field of safety engineering, long since neglected, is coming into its own. The postwar period will see the introduction of many such programs.

INDUSTRIAL-HEALTH CONSIDERATIONS

Another broad field of work to which standardization can be applied with a very large return in service is that of industrial health. The efforts of war production have introduced many new chemicals and substances which create toxic conditions for those working with them or handling them. Industry has performed miracles during the war in working with these materials with a minimum accident experience, but it has done so at great expense in time, effort, and money because of the lack of carefully digested information. The whole subject of elimination of hazards to the health of workers has not received the attention it deserves. This found us in a position of unreadiness when the great pressure of war came upon us. This must not be allowed to continue. We are in a chemical age. What we have seen in the way of new substances and new ways of using old substances is a mere drop in the bucket compared to what we may see in the years to come. It is my firm belief that many of these new substances and new uses of old substances will not be introduced into our industrial operations in the future until the hazards involved are fully known and controlled methods developed. These facts will be assembled through the standardization process and be made available as standard techniques.

Certain work has already been accomplished. The fundamentals of the design and construction of exhaust systems used to keep the atmosphere free from harmful substances have been standardized. Minimum requirements for sanitation facilities have been prepared. Allowable concentrations for a number of toxic dusts and gases have been established. Rules for safety in electroplating operations have been promulgated. Methods of handling the hazards of grinding, polishing, and buffing operations have been agreed upon. Many other items could be mentioned.

The fact remains that allowable concentrations for literally hundreds of toxic substances need to be developed. Standard instructions on the safe methods of handling these substances must be prepared. Containers holding toxic or flammable substances must be labeled according to a uniform pattern such as that which has been established by the Manufacturing Chemists Association, in order that those who handle the substances will be fully aware of the hazards involved. These are but a few of the problems connected with maintaining the health of workers on a high level which must be and will be solved in the years ahead. Standardization again will very largely lead the way.

No mention has been made of safety in the design of homes, of highway safety, of the broad field of air, water, and land transportation, of training methods, aerodynamics, irritants, contaminants, radiation, sensitizers, and a dozen and one other such items which space does not permit treating at this time.

However, there is still one further prediction in regard to safety standardization that I would like to make.

THE "STANDARD WAY" TO SAFETY

Despite the 25 years of national safety-standardization work that has been carried on, the wealth of technical information which this work has developed and made available to industry, and the great variety of problems which daily face management in carrying forward accident-prevention programs, only a very limited number of plant managers and safety engineers use the standards which have been developed and assist in the development of standards or in establishing the need for standards. Increasingly, however, there are evidences that the "standard way" is the way of the future.

Why do I say this? The answer is very simple. If you and Bill and John and this group and that group study a particular accident hazard and separately publish the results, and I in my desire to handle that hazard in my own plant read these publications and find that complete agreement as to the facts and conclusions does not exist, I am confused and receive no help. The chances are I will then proceed to make my own studies, and, if I publish my findings, I will add to the confusion for the next fellow. If, on the other hand, you and Bill and John and this group and that group, realizing that you have a common problem, get together around the table and reach agreement on the facts and conclusions and publish your findings jointly, then I, in using your publication, do so with the confidence that I have just the information I need. It is authoritative.

Just so with the "standard method." A standard is nothing more than a compilation of agreed-to data made authoritative through the consensus of acceptance.

The day of the prima donna in accident prevention is over. It costs too much to insist upon one's own individual ideas. Too much time is consumed in developing those ideas unless a pioneering job has to be done. The "standard way" is the "authoritative way." In the years to come the standard way will become the common way, the usual way, the universal way.

WAGING WAR AGAINST ACCIDENTS

We in conjunction with our allies have recently completed the job of overcoming two of the most cruel and barbarous enemies in history. The effort has cost us much in life, injury, money, time, and in many other ways too extensive to enumerate. We have an enemy right here at home almost as ruthless in its destructive ability. Industrial accidents cost 18,000 lives per year to say nothing of injury, lost time, and monetary loss. Are we willing to admit that we can join with others and win a cruel and bloody war such as we have just won but cannot control at home such a destructive force as accidents create? Certainly not. But to win the war at home requires the effort and co-operation of all of us just as it did to win World War II. We must use every tool and technique that is available to us. Standardization is one of the tools.

SAFETY AND EFFICIENT MANAGEMENT

The essence of efficient manufacture is orderly administration in the factory which has given rise to the science of production control. Accidents interrupt efficient manufacture and break down production control. Standardization means doing things in an orderly and well co-ordinated manner, which is one of the prime essentials in effective management. Standards, therefore, are not dead documents. They are alive, forceful, dynamic. Their use builds up effective management which accidents tend to pull down.

In the spirit of a motto of the American Standards Association which says, "Standardization is dynamic not static—It means to move forward together," let us move forward together using every weapon at our command to destroy accidents, as a menace to our society and economic life.

Locomotive Trends on the Pennsylvania Railroad

(*Continued from page 422*)

motives, known as the "T-1," have been so successful that 50 additional units are now being built to handle high-speed passenger trains between Harrisburg and the West.

In 1944 the Railroad Company's engineers adapted the principles of the "S-1" engine to the development of a high-capacity freight engine, 26 of which, known as the "Q-2," have been built and placed in service. These engines also are of the four-cylinder type and are giving a very high standard of performance in the railroad's through freight service.

TURBINE LOCOMOTIVE

At about the same time that the development of the "S-1" was started, the railroad engineers commenced a study of the possibility of applying a steam turbine to a steam locomotive and in 1940 secured the co-operation in this effort of the Baldwin Locomotive Works and the Westinghouse Electric Corporation. This co-operative effort resulted in the design and construction of an entirely new type of locomotive, known as the "S-2," in which the motive power is furnished by a geared turbine instead of steam cylinders. This engine has been in successful service for over a year and has characteristics very similar to the "T-1." After it has been thoroughly tested in service it is to be placed on the Altoona test plant and a complete series of tests conducted to develop its characteristics.

CONCLUSIONS

From this brief discussion general conclusions may be drawn as follows:

1 The steam locomotive, originally the main motive-power unit of the railroads of the country, has developed from a unit of relatively insignificant capacity to the present modern, high-speed, high-capacity, high-economy units, clearly pointing to the fact that as locomotives of greater capacity are required in the transportation industry, the ingenuity and resourcefulness of those responsible for their design cause them to be developed and placed at the service of the railroads.

2 As new devices to improve the efficiency, capacity, or tracking characteristics of locomotives are developed, no difficulty is experienced in building and placing in service locomotives embodying these characteristics.

3 As locomotives of greater power and higher speed are developed, improved roadway clearances, heavier rail, and better roadway structures are provided for their use.

4 Many different types of locomotives are used in railroad service to good advantage when necessity for them is evident.

5 Each of these types can be adapted to the requirements of a railroad in so far as tracking ability, capacity, and low maintenance are concerned.

ACKNOWLEDGMENT

In preparing this review, material has been drawn freely from the book, "Motive Power Development on the Pennsylvania Railroad System," by Paul T. Warner. The author wishes to acknowledge his debt to Mr. Warner for the help his careful work on this subject has been.

Human Approach in Leadership

(*Continued from page 442*)

any aptitude for leadership and yet, when they went out into the world of affairs, they often found themselves faced with executive responsibility and inadequately prepared to assume that responsibility.

ENGINEERS NOW TRAINED IN LABOR RELATIONS

So we all became convinced that it was imperative to have at engineering schools and schools of business administration, adequate courses in labor relations. As a result, many engineering schools and schools of business have wisely put in such courses, but there are still many that have failed to do so. And so we have a long way to go.

Let me add that by and large, the real difficulty of labor relations in the factory has been one of neglect. Many executives have treated the question of human organization as a minor matter and not as a major problem. They have failed to appreciate that the adoption of effective methods of human organization could have a maximum effectiveness, both in securing production and in promoting an identity of social interests. While there are limits to what an individual employer can pay in wages, the only limits in achieving results applied to industrial relations and other problems of management are his intelligence, ability, and good will.

Superficially, these details of labor administration may seem important, especially when considered singly. But it is well to remember that it is not always the largest part of the machine that causes the most trouble. It is also essential to perfect the ball bearings though they may appear infinitesimal in size as compared with the whole machine. Faulty ball bearings may wreck the entire works.

Electrical Standards for Machine Tools

(*Continued from page 448*)

land, Ohio, and copies of the Automotive Standards alone may be secured from any of the automobile manufacturers in the Detroit area.

STANDARDS APPLICABLE TO OTHER MACHINES

Although these standards apply particularly to electrification of machine tools, many inquiries from builders of other types of machinery have been received, and of course they are always welcome to use the standards for their guidance. It is believed that these standards represent sound engineering practice, and for any machinery operating under conditions similar to those under which machine tools operate, they should be of great assistance in doing a first-class electrical job.

Although it has been impossible at this time to arrive at one set of standards to cover all conditions, it is believed that these standards represent a great forward step in the proper electrification, and economical manufacture of machine tools. Instead of approximately twenty-five sets of conflicting electrical specifications previously used, there are now two standards, and it is not too much to hope that eventually there may be one American Standard for the electrification of machine tools.

The great problem now is to convince the machine designer of the necessity of devoting the attention to detail in the application of electrical equipment that he does to other important elements of the machine. Electrical equipment is an important part of the machine, and unless treated as such, the full capabilities of the machine will not be realized.

The electrical engineer, or the electrical manufacturer should be called in early in the design program for the machine, and given the necessary space and co-operation to do a good job. This is the only way in which the best over-all machine design can be produced.

Management Control of Industrial Accidents

(*Continued from page 445*)

year 1945, up to the time of preparation of this paper in November.

1 The frequency of lost time in accidents per million man-hours was reduced from 24.8 to 3.7, a decrease of 85 per cent.

2 The severity of lost-time accidents in days lost per thousand man-days worked was reduced from 0.28 to 0.085, a decrease of 70 per cent.

3 The frequency of compensated accidents was reduced from 105 to 18.5, a decrease of 82 per cent.

4 The frequency of occupational minor accidents has been reduced from 4900 to 1016, a decrease of 78 per cent.

5 The cost per employee for occupational accidents has been reduced from $24.62 to $8.60, a decrease of 65 per cent.

By improving the accident experience which we had during 1941, during the direct war period from December 7, 1941, to August 14, 1945, we were able to save 673,203 man-hours or the equivalent of 337 men working for a period of one year.

Some Observations on World Industrialization

(*Continued from page 410*)

It is not necessary to go further into the details of this proposal now. I love my profession. No one can appreciate more fully than I the significance of its past performance, notably since the turn of the century. I have known intimately and worked with many of the leading engineers of my period—John Fritz, Henri Le Chatelier, Charles de Freminville, Frederick W. Taylor, John R. Freeman, Ambrose Swazey, John Brashear—skilled in performance, yes, but dreamers too. I am sure that they would join me in praying that our distinguished profession might swing into the tempo of the times by making this task its own. My greatest hope is that at some future date the traveler may find on the walls of one of the buildings of the United Nations Organization a tablet reading somewhat in this fashion:

This tablet is erected by the United
Nations Organization to honor
THE ENGINEERS OF THE WORLD

represented by their internationally federated societies, who, appalled by the poverty attending the lives of over half of the world's people, and inspired by the loftiest motives of disinterested public service, and recognizing that the times demanded new concepts and new efforts for the safeguarding and promotion of our civilization—have through the years made constant and fruitful suggestions for the amelioration of the lot of the most unfortunate of our fellow men.

Quamdio fecistis uni ex his fratribus meis minimis, mihi fecistis.

WHAT KIND OF A WORLD?[1]

By NORMAN J. PADELFORD

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

IN the wide discussion which has been taking place in the United States concerning the methods of preventing atomic energy from being used to blot out civilization one thread has run through all arguments. This is that some means of control must be employed to prevent certain nations from developing atomic war power.

A notable group of scientists has now presented another statement regarding the physical properties of atomic energy and a plea for its control. "One World or None"[2] deserves reading by engineers and laymen alike. It will be one of the most talked-of books of the year. It is divided into two parts, the first dealing with the scientific and military aspects of atomic power. The second part deals with the political problem—particularly that of international controls—and will be the principal object of discussion here.

The first of the articles in the second part by Leo Szilard is devoted to the question, "Can We Avert an Arms Race by an Inspection System?" The second and longest of the articles, by Walter Lippmann, is entitled "International Control of Atomic Energy." A brief paper by Professor Einstein is entitled "The Way Out," and the final article is an appeal by the Federation of American (Atomic) Scientists for support of their program.

In substance, Szilard, Lippmann, and Einstein suggest that: (1) There must be some rigorous form of international regulation of the production, storage, and use of atomic energy; (2) there should be an international inspection system to watch research and technological developments in all countries; and (3) sooner or later there must be a world state with imperial control of atomic development.

The authors of "One World or None" foresee dire consequences for civilization, and particularly for the United States, if there is an atomic armaments race. It is possible that this may be the case. Nevertheless, the history of armaments generally as well as present-day news from foreign countries concerning atomic research forces one to surmise that no great nation is likely to rest content until it, too, possesses the weapons of atomic energy. Actually, an atomic race has been under way since before World War II.

The position in some foreign countries can perhaps be understood if it be supposed that the Soviet Union had been the first to obtain atomic weapons and had then proposed that all nations be prohibited from developing atomic power for military purposes. Is it conceivable that the United States would have been eager to rush into a convention prohibiting nuclear research and experimentation with atomic power? It should not be surprising then if some other countries are less reluctant than idealists imagine that they should be in concluding an agreement limiting or prohibiting development of atomic power. Americans need to bear in mind that others do not always interpret our actions as we do and that there is fear of what American military or industrial power may do in some parts of the world.

Does this mean then that we are doomed to a third and final world war? It seems to the reviewer that this does not necessarily follow. Many nations have adjusted their armaments in competition with others without necessarily becoming involved in war. The possession of armaments has in some instances led nations to embark upon the path of war when without arms they have eschewed such ventures—witness the case of Nazi Germany. In the last instance, however, it is not the armaments which produce war out of any given situation but the political determination of the leaders to gain certain ends by whatever means may be necessary. Once nations have acquired aggressive ambitions they are likely to regard war as justifiable means to their end. Nations disposed to live and let live are not likely to resort to war, regardless of the number of weapons they possess, unless they are attacked by others. This has been the case with the United States, the British Empire, and the Soviet Union in the last twenty-five years. It is difficult to see that the atomic bomb will change this situation. Indeed a prohibition adopted by the peace-loving states would play directly into the hands of Germany, Japan, or some potential aggressor, just as American limitation of naval armament after 1922 greatly strengthened Japan's relative power position in the far Pacific. This lesson of history, pointed up by Pearl Harbor, deserves pondering.

Now let us turn to the problem of international regulation. Szilard, Einstein, and Lippmann suggest as a first step a system of international inspection of methods and installations used in the production of atomic weapons. This might take the form of a military inspection body or, preferably, a commission made up of civilian scientists and engineers whose duty would be to regularly inspect every country. Such a body might report to the United Nations Security Council, an arrangement possible under the terms of the resolution adopted by the United Nations General Assembly in London in January, 1946. The Security Council would then take such action as it might be able to agree upon in any situation threatening peace or security.

Both practical and political questions concerning the jurisdiction of such a commission and use of the information gained by it arise at once. How extensive would the inspection be? Would the inspectors have the power to force their way into private laboratories wherever fancy led them to want to pry into scientific or engineering secrets? Would the commission have the authority to publicize any manufacturing processes?

This raises the serious question of whether there is to be a communalizing of every research project, every discovery, every industrial technique and "know-how" which is conceivably related to the study or application of atomic energy? If so, a revolution in the entire concept of copyrights, patent laws, and private property is involved. If the nations agree that atomic developments shall take place only upon express authorization of some international body, it is difficult for a political scientist to see how an inspection system is to be fully effective in warning the world of dangerous activities unless carried to this extreme.

An almost equally difficult problem arises over the ancillary question of what is to be done with the results of the inspections. Will the information be made available to all governments and individuals? If so, what is to prevent a potential

[1] One of a series of reviews of current economic literature affecting engineering prepared by members of the Department of Economics and Social Science, Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Opinions expressed are those of the reviewer.

[2] "One World or None," A Report to the Public on the Full Meaning of the Atomic Bomb. Edited by Dexter Masters and Katherine Way. Whittlesey House, New York, 1946, 79 pages, $1.

aggressor such as Germany from assembling needed information to construct armaments with which to threaten the world while a peace-loving nation such as the United States, for example, would be curbed in its atomic investigations? If, on the other hand, information is kept secret, suspicions of power politics are certain to arise. Charles will be made that some nations are obtaining secrets at the expense of others; that sanctions are being imposed on research and technology which are not intended for warlike purposes. Dangerous disputes could result which might well threaten peace and security as much as if there were no inspection system.

The more serious supplementary problem which arises in connection with an inspection system may be anticipated over suspected denial of access to atomic laboratories or plants by such a ruse as, for instance, nonavailability of transportation over difficult terrain, coupled with denial of any activity there by its government.

Walter Lippmann goes so far as to advocate that "treaties must be designed directly to nullify the sovereign right and to destroy the actual power of any government to make a state secret of the development of atomic energy." That is pretty strong dosage. Is it conceivable that the Senate of the United States, for example, would give its consent to a treaty containing such provisions binding upon the United States of America?

Theoretically speaking, an international inspection system sound like a logical proposition. Under ideal circumstances it might prove to be workable and effective. Under the less than ideal conditions in which contemporary international relations are being conducted it has within itself seeds of trouble which might lead to the very war which the atomic scientists cry must be avoided.

Szilard and Lippmann go one step farther. Each argues that the atomic threat cannot be fully met without a world state endowed with sufficient power to prevent, by force if necessary, any but its own instrumentalities or licensees from having atomic weapons or engaging in activities relating thereto. Walter Lippmann would give the world state jurisdiction over individuals everywhere, just as the United States Federal Government has jurisdiction under the Constitution over all persons within the United States for certain defined purposes.

Whether the Lippmann thesis of individual accountability or the more generally advocated course of a superstate with coercive powers be taken as a starting point for reasoning, one is pushed back against the same undeniable fact: Save as a result of a popular uprising the world over or by world conquest by one state, the world state can be founded only by free agreement among the present sovereign states. It may be quite true, as Lippmann argues, that there is a growing international principle of individual responsibility. He cites the punishment for piracy and the case being made against war criminals in present war-crimes trials at Nuremburg as evidence. In this he makes a good point, for it may very well be that a significant step is being taken in international law. It may also be true, as he likewise argues, that the United Nations has within it the potentialities of a world state. Nevertheless, in view of the difficulties which continue to characterize the relations of the nations, both within and outside of the United Nations as it now exists, in matters less sweeping than world union it seems somewhat doubtful whether they will be prepared for some time to supersede the United Nations arrangement with the radically different form of government the world state implies.

The experience with government the world over and through the ages has shown that if government is to have real regulatory powers it must also have freedom of decision on how and when to act, with sufficient force to compel dissident groups.

There is no basis for supposing that such a far-reaching field as production of atomic weapons can be kept within bounds and monopolized in the hands of the world state unless that government develops legislative control, and enforcement powers that are separate from and *greater* than those possessed within their own domestic spheres by such powerful governments as those of the United States and the Soviet Union. This would mean superimposing another layer of government above what we have now. It would imply that one kind of research might be ordered undertaken in one country and prohibited in another; one kind of atomic manufacture forbidden in the United States but permitged in the Argentine. One group of states might be permitted to operate atomic-energy plants because they happened to enjoy a voting majority in the world government while others would be refused such a right. Highly inflammable situations can be visualized arising out of such day-to-day transactions of the world state.

Would the creation of the world state guarantee an end to war? Perhaps, but not necessarily. Some of the most highly governed states have at one time or another undergone civil wars which in destruction and loss of life have equaled or surpassed international wars. International war as we have just experienced it might be no more. But within the world union there might still take place international civil wars which would be just as terrible as World War II.

The new physics may "require a new politics." But it must be a politics which is new, which tolerates freedom and promotes human progress, not a politics which entails the old disorder of autocracy and dictatorship in larger robes.

The fear of the atomic bombs, as well as the desire to maintain what are thought to be "secrets" may, as Prof. Charles Merriam, one of the wisest students of government, has observed, lead to the worst controls and restriction of freedom mankind has ever known. Voices have been heard in this land in the past demanding liberty or death. That is a cry which has rung in many lands where government has repressed progress, denied freedom of thought, and abridged human liberties. Some men may well conceive that no world is preferable to one world if the government of the latter is to be so authoritarian that universities, industries, national states, and the press are to be ruled from a world capital in a manner comparable to that of wartime controls in some countries.

This is not a counsel of despair. Progress can and must be made toward a reasonable world government and toward peace and security. But mankind is not uranium 235. It cannot be converted by mechanical process into some new Utopian element. It can move forward toward more effective social and political organization only as experience leads it. The trend of political history has been toward more and more international organization. Given a period of experience with the United Nations organization, the present arrangements may be amended and improved. This is not likely to take place, however, until some of the nations have a larger degree of confidence in one another and in the operation of international government than they have now. One World can be organized but it will be done by political fusion and not by political fission.

Progress can come only by agreement, and this can be obtained only by coercion or by mutual accommodation. The former will be rejected as being fascism. The latter can be attained only by the slow process of negotiation.

The real problem which confronts the world today is not so much the control of atomic energy per se as it is the cultivation of "the ability of all peoples of all kinds, to live together and to work together in the same world at peace." We are back to what Pope once said, "The proper study of mankind is man."

It is submitted by the present reviewer that the time has come, for Americans, in particular, but others as well, to take a somewhat less hysterical view of the atomic bomb and to undertake a scientific evaluation of what kind of a world we wish to have.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given

Industrial Research

IN the foreword of the *Sulzer Technical Review*, No. 1, 1945, F. Oederlin, managing director of Sulzer Brothers, Limited, Winterthur, Switzerland, gives an account of the attitude to industrial research in general, the equipment in the service of such research, and the views on scientific investigation and technical development which guide the work done by the firm. The writing of this account was prompted by the opening of Sulzer Brothers' Central Research Laboratory, at Winterthur, which unites the physics, chemistry, and metallurgy laboratories, and the material-testing department, hitherto housed in separate buildings, under one roof.

Interesting to note here is the attitude of Sulzer Brothers toward industrial research. Mr. Oederlin writes: "It is our opinion that in the prosecution of research work the engineering industry should depend on its own initiative and wherever possible on its own financial resources, and not upon direct state aid, which can better be replaced by other forms of encouragement, such as the reduction of taxation on research undertakings. Purposeful and scientifically pursued industrial research is closely bound to the works which promote it and cannot be separated from the manufacturing departments. It has always been courageous private initiative which, in the free play of competitive forces, has produced the economically valuable triumphs of engineering. We are at the same time well aware that the research departments of the Swiss Federal Institute of Technology and other institutions of this kind do a great deal of valuable work, especially in the investigation of fundamental theoretical principles such as can later be utilized in industry. In this they complement industrial research activity to very happy effect, while at the same time fulfilling the important task of training young research engineers for later industrial employment. In particular, regular contact with the leading teachers in our technical universities does much to further and supplement the industrial research done in engineering works. Such an exchange of ideas, of course, is also profitable for the universities themselves, which are thus enabled to keep in close touch with the aims and problems of industry."

To give readers some idea of the possibilities opened up by research activity in all branches with which Sulzer Brothers is concerned, a brief enumeration is given of the laboratories and scientific centers, together with some details as to the fields of work they cover.

The physical laboratory, in collaboration with other laboratories and research centers, handles problems of applied physics which are of importance for the further development of existing products and for new lines of advance. One of the main tasks of this laboratory is the provision of appropriate measuring and testing methods, which have been rendered possible by the development of thermionic valves and the technique of connecting them. Complicated phenomena, such as cavitation in hydraulic machines, or injection and scavenging processes in Diesel engines, are investigated by means of spark photography. Special methods are employed to examine the structural durability of gas-turbine and compressor blades. The physical laboratory further deals with the measurement of temperatures by thermoelectric and optical means.

The metallurgical laboratory is concerned chiefly with the supervision, improvement, and further development of foundry products such as cast iron and steel, and heavy and light nonferrous castings. New metals and new working methods are tried out by laboratory experiments and service tests conducted with up-to-date melting and annealing equipment. The test results, service data, and observations thus collected by the metallurgical laboratory are later evaluated with the aid of modern mathematical and statistical research methods, which permit a maximum of useful material to be obtained in a minimum of time spent on trials.

The increasing claims made on the accuracy of analyses mean that more accurate analyzing methods are continually having to be worked out and this task is allotted to the chemical laboratory. While in the past the quantitative analytical determination of the constituent elements to within 0.1 per cent was sufficiently exact and took days to complete, it is now often necessary to carry out analyses to within 0.01 per cent or even less in a matter of minutes. The efforts made in this direction are facilitated by spectral analysis. Other important domains of this laboratory are corrosion phenomena and the softening of water. Apparatus of alloy steel and other special alloys is being used more and more extensively in the chemical industry; and only by means of systematic corrosion tests it is possible, for instance, to select in advance the metal best suited to the end in view. Apart from the investigations continually being made on mineral oils, water, coals, slags, and gases, many products are tested, some of them coming from the wide variety of the company's own manufactures and others from outside suppliers.

In modern engineering the importance of flow phenomena grows daily, not only in machines through which a fluid is actually flowing, such as compressors, pumps, and turbines, but also in heat engines, where the guidance of air and combustion gases sets the designer difficult aerodynamic problems in his endeavor to secure the highest possible efficiencies. The aerodynamic laboratory is furnished with the most modern equipment for grappling with these problems. At the present stage of engine and machine construction it is no longer sufficient to ascertain the final effect of an experiment merely by making pressure measurements or determining the efficiency. Instead, every detail of flow must be determined with the utmost accuracy, which leaves no other alternative than to investigate the thin boundary layers and the degree of turbulence. These measurements are possible only with appropriate methods and extremely delicate measuring instruments. The results secured with the model must also be continually compared with the latest knowledge of the theory of flow in order to insure judicious incorporation of new features in the engines and machines manufactured.

Problems of heat phenomena can be clarified with the help of

testing equipment and test beds which stand at the disposal of the departments concerned with steam generators, various metal apparatus, and heating and ventilating installations. Special facilities are also provided for trying out governors, regulators, and other fittings and for investigating dust-collecting problems.

The material-testing department has the double duty of submitting all material entering the works to acceptance tests and of carrying out research work on the properties of materials in conjunction with the physical and metallurgical laboratories and the research centers concerned. A committee for the promotion of all branches of material testing and research sees to it that all the endeavors made are duly co-ordinated. Particular importance is attached to first-class welding methods and the testing of welds, which have been largely responsible for advances in the construction of high-pressure pipe lines and pressure vessels, to mention only two products. The material-testing department in general, by virtue of its combination of practical control and theoretical research work, is of extraordinary value in maintaining and improving the quality of all products manufactured. Collaboration with the Swiss Federal Institute for the Testing of Materials also promotes the work done along these lines.

Liquid Heat

THE practicability of applying a high-temperature liquid of suitable characteristics, circulated from a central heat source, to the various required domestic services was described by Orion O. Oaks, chief engineer, John B. Pierce Foundation, in a paper appearing in *Heating, Piping, and Air Conditioning*, January, 1946, *A.S.H.V.E. Journal* Section.

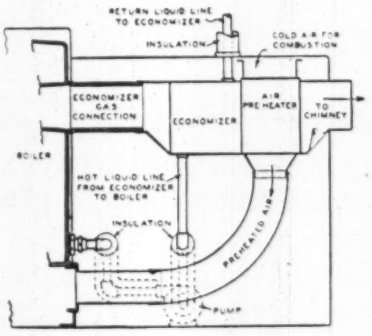

FIG. 1 BOILER UNIT

Tests of a practical nature were conducted to determine the economy of the operation and the cost compared with that of conventional equipment in current use. The method employed involves the circulation of hot liquid from the primary generator or boiler to and through jacketed baking ovens, submerged coils, radiant panels or coils, and the return of the liquid to the boiler for reheating and recirculating.

Mr. Oaks experimental installation includes a boiler, uniheater, hot-water heater, steam generator, refrigerator, and cooking unit.

The boiler or primary generator is of the liquid-tube liquid-wall type with a built-in economizer and a built-in air preheater.

The house-heating unit may be of the liquid-tube air-heating type with all the necessary and customary features, such as a humidifier, air filter, circulating fan, and if desired, a cooling and dehumidifying coil for summer cooling. This unit, which is under complete automatic control, is contained in a housing and may be located at any convenient point in the building.

The hot-water-supply unit is in the form of a heat exchanger with submerged hot-liquid coils and may be of the tankless instantaneous type or may be used in connection with a storage tank.

The refrigerating unit is a standard machine of the absorption

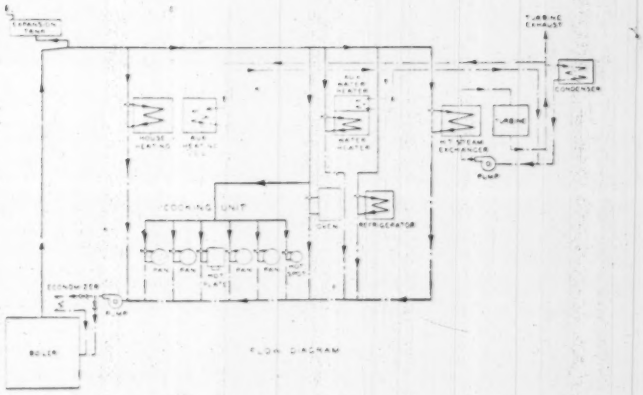

FIG. 2 FLOW DIAGRAM FOR HIGH-TEMPERATURE LIQUID

type and is adapted to use with liquid heat by the simple substitution of a hot-liquid coil in place of the existing heat source.

The cooking unit consists of metal pots of various sizes which are depressed in an insulated working table. Fitted to the pots are cooking utensils or liners which are provided with insulated metal covers. Set flush with the worktable are a service hot plate and a flat surface griddle. A small sink is incorporated for convenience in food preparation.

The baking unit consists of a compartment or compartments conforming to standard oven dimensions and is provided with raise-up or open-out flush-mounted doors as desired.

When suitably equipped, the ovens can be utilized as a dishwasher, thereby employing the heated surface for a rapid production of steam and boiling water which is sprayed over the dishes. After rinsing, the oven can be used as an effective drying device.

The time required for raising the various units from a cold condition to a working temperature varies from 30 sec in the case of the cooking pots, griddle, service plate, etc., to 2 min in the case of the ovens.

Drying of laundry and dehydration of fruits and other foods are readily accomplished by radiant heat and for convection as required.

The hot liquid circulates through the system at atmospheric pressure; therefore an expansion tank is used to absorb the increasing volume of the liquid as the temperature increases.

A motor-driven centrifugal pump is employed to circulate the liquid throughout the various units and return it to the generator for reheating and recirculation. This pump operates only against the head created by frictional resistance through the lines.

When needed, electric energy is produced by means of a heat exchanger or boiler producing superheated steam at pressures varying from atmospheric to 750 psi. This steam is used to drive a steam turbine, which is connected to a generator, to produce electric current of whatever characteristics may be required.

The liquid employed as the heat distributer is tetracresylsilicate. It has a boiling point of 817 to 825 F, specific gravity 1.13, and specific heat 0.43. Although viscous at minus 65 F its solidifying point is undetermined. This heat vehicle is nonpoisonous, nonexplosive, noncorrosive, and nontoxic. Its viscosity is similar to S.A.E. 20 at 70 F and it is extremely fluid at temperatures above 100 F.

The heat-transfer properties of the liquid follow closely those of other high-boiling-point liquids and are similar to those of water at like temperatures, namely, at 300 to 600 F, which is the range considered in this paper.

A full-scale working model of the apparatus, which was invented and developed by Mr. Oaks, has been under successful test operation and study for the past year.

Heat Pump

WHEN the firm, Bell Company, Basel, Switzerland, butchers and sausage manufacturers, was confronted with the curtailed fuel quotas of recent times, it was difficult to maintain their business in its previous volume and at the same time uphold their high standard of hygiene and their up-to-date methods. To fulfill these requirements meant that, in spite of fuel restrictions, the necessary heat and above all the hot water needed for cleaning and scouring had to be provided as before.

The installation of a modern heat pump was proposed by Sulzer Brothers of Winterthur. A description of the effectiveness with which this was accomplished is to be found in the *Sulzer Technical Review*, Nos. 3 and 4, 1944.

The problem was to heat daily, from 10 to 70 C, about 60,000 liters of fresh water drawn from the municipal mains, that is, to produce some 3.6 million calories per day. The hot water was to be made available in the factory, particularly for cleaning and scouring purposes.

In this case a very favorable source of heat was available in the refrigerating plant which has been in use at Bell Company for more than 30 years. The refrigerating plant, itself nothing but a heat pump, draws a considerable quantity of heat out of the cooling and freezing rooms both in summer and winter. Instead of letting this heat run to waste with the cooling water, as was done in the past, it can now be passed on (at least in part) to the new heat pump in the form of compressed ammonia gas at a temperature of 18 C or more.

The heat supplied by the refrigerating plant is pumped up to a temperature level of about 72 C, which is required to provide a hot-water service at 70 C, in a newly installed two-stage reciprocating compressor of horizontal design. Two-stage compression was necessary both for better compressor efficiency and to avoid excessive final compression temperatures. The two new compression stages are lodged in two separate cylinders arranged one after the other on the same piston-rod and are double-acting.

The combined refrigerating and heat-pump plant works with three-stage compression. The service conditions allow all heat, even that normally undesirable, to be utilized by being transmitted to the water to be heated. Thus the following could be turned to useful account, see Fig. 3.

(1) The superheat of compression of the refrigerating cycle in the gas cooler E. (2) The superheat of the ammonia gas compressed by the first heat-pump stage in the gas cooler F. (3) Part of the compression and friction heat of the two heat-pump compression stages through the cooling jackets of the compressor H. (4) At least part of the superheat of the gas compressed in the second heat-pump stage in the oil separator J (cooling effect desirable for purpose of better oil separation). (5) The whole condensation heat of the ammonia gases compressed by the heat-pump compressor in the condenser K. (6) Part of the heat still contained in the liquid ammonia in the bottom element of the condenser K serving as an aftercooler.

In spite of the fact that the temperature of heat utilization is very high for heat-pump practice, the appropriate arrangement of the various heat-exchange apparatus, combined with other favorable factors, particularly with regard to the source of heat, resulted in a plant of exceptional economy, as the following particulars show: Heating output per hour, 180,000 cal; energy required, measured at driving-motor terminals, 46 kwhr; specific heating power, 3915 cal per kwhr; or power factor, 4.55.

The flow of water through the heat-pump plant is regulated automatically by means of a thermostat and a motorized regulating valve in accordance with the final temperature of the water. As the water consumption is subject to pronounced fluctuation, an insulated hot-water storage tank with a capacity of about 50 cubic meters was erected in an elevated position, and from this the hot water is distributed down descend-pipes to the various departments. This tank also enables the heat pump to be shut down during certain prescribed hours.

The plant is equipped with all the necessary protective devices which in case of trouble stop all service or operate an alarm to warn the attendant staff.

This plant illustrates how large concerns of vital national importance can make their heat supply independent of fuel resources, and can do this economically and with comparatively simple means. The savings possible in service at present-day fuel prices allow a very rapid recovery of the cost of the plant, so that the installation will remain a paying proposition when fuel prices return to peacetime levels.

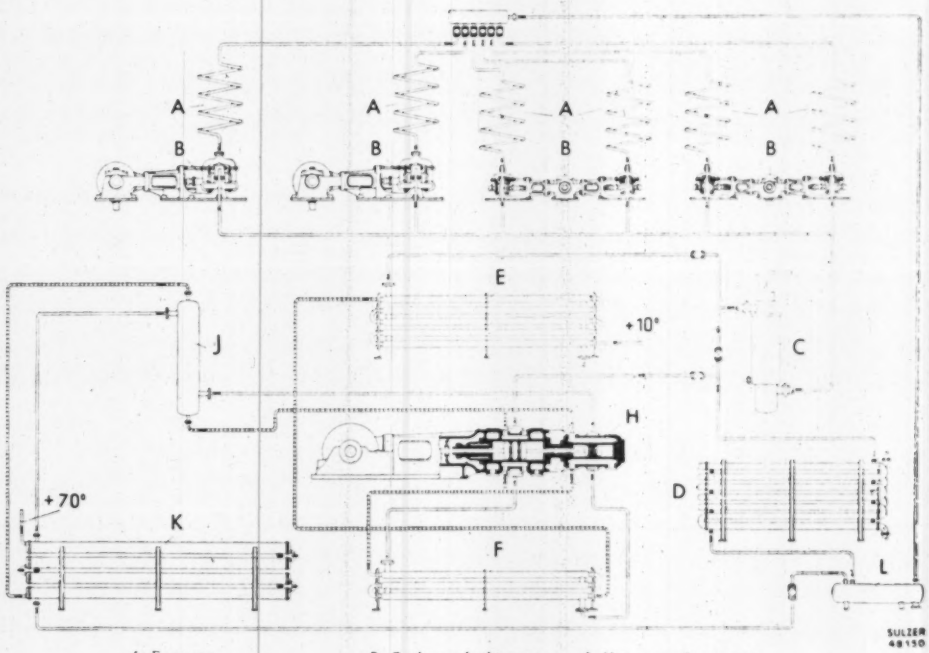

FIG. 3 GENERAL ARRANGEMENT OF THE COMBINED REFRIGERATING AND HEAT-PUMP PLANT

Beryllium

BERYLLIUM products, reveals the *Industrial Bulletin* of Arthur D. Little, Inc., February, 1946, were so scarce during the war that imports of ore by air from South America were sometimes necessary and the total imports soared to ten times the prewar figures. With the end of the war, demand slackened and producers can now seek new outlets. Considerable interest is being devoted to beryllium compounds, the first form in which beryllium was used, although the metallic form later overshadowed them.

Beryllia, as beryllium oxide is commonly known, can be used as a refractory at extremely high temperatures, around 4000 F, where it is said to show high electrical resistivity and thermal conductivity and the best resistance to rapid changes in temperature of any commercial refractory. Fused beryllia can be obtained to almost any desired mesh characteristic and is adaptable to producing shaped ceramic objects. It has been considered for crucibles for casting metals which melt at unusually high temperatures, as well as for electrical insulators, combustion tubes, linings for high-temperature furnaces, and similar applications. Recent work indicates that by special fabrication refractory bodies of fused beryllia can be rendered gastight. Beryllia, widely used in the "phosphors" coated on the inside of fluorescent lamps, extends the color range and intensity of the tube's glow. Beryl, the ore of beryllium, has long been used in vitreous-enamel compositions to clarify chrome colors; now beryllia can reportedly be used to advantage with the less active beryl.

Beryllium sulphate is used with zinc and cadmium salts to increase the glowing period of phosphorescent compositions, such as have been used in direction indicators for blacked-out ships and in printing inks for after-dark advertising displays. Compounds of beryllium with stearic and similar organic acids to form "soaps" are useful as additives to make the viscosity of printing ink more uniform. The potentialities of the beryllium compounds have not yet been thoroughly investigated, but enough has been learned to suggest them as additives for many specialty applications.

Copper alloys containing about two per cent beryllium show remarkable retention of elasticity; even under conditions of heat and corrosion, springs made of this alloy are unusually uniform in strength. The alloy is also unusually hard, conductive of heat and electricity, corrosion-resistant, and low-sparking. It was used extensively during the war in precision instruments, aircraft-engine components, Signal Corps apparatus, and safety tools for munitions plants. Other alloys containing as little as 0.1 per cent beryllium are less expensive and and give promise, especially where high electrical conductivity is required.

Beryllium as a pure metal remains a rarity because of the difficulty of producing it; it is used principally for x-ray tube windows, where its heat resistance and high transmission of x rays are attractive. Beryllium is the lightest of the stable metals, but so brittle that it has not been used structurally, even if its cost is disregarded. Alloys of 40 per cent beryllium and 60 per cent aluminum are remarkably elastic, tough, and machinable, but too costly. Beryllium has advantages as the "moderator" for slowing neutrons in the plutonium pile used in atomic-bomb production, but was rejected in favor of graphite because beryllium was not available in sufficient quantity.

Beryllium products are derived principally from beryl, crystals of which must be hand-picked from the associated materials. Deposits exist in the western United States, but the leading western hemisphere sources are Brazil and Argentina. Beryl contains only four to five per cent beryllium and must go through complex and costly processing before beryllium oxide is obtained. Fabricated two per cent beryllium copper costs at least $1.12 per lb, but has been in great demand. Beryllium compounds are similarly expensive, but many specialty applications worth the price have been found and more are expected.

Hemispherical House

A MASS-PRODUCED hemispherical house, designed to provide at low cost a higher standard of living in terms of space, health, comfort, convenience, and work-saving was announced by Fuller Houses, Inc., Wichita, Kan., at a press conference held March 19, 1946, in the Ritz Carleton Hotel, New York, N. Y. Herman Wolfe, president of the company, stated that Beech Aircraft Corporation, of Wichita, a subco ntractor, expects to manufacture 200 houses per day beginning early in 1947.

The Fuller house, named for its designer, R. Buckminster Fuller, is a circular house containing 1017 sq ft of floor space which is divided into a combination living- and dining-room

FIG. 4 LIVING-DINING SPACE OF CIRCULAR HOME
(Some inside features of the house are: built-in curtain rods, leather-like plastic fabric-covered walls, and indirect lighting of controllable intensity.)

area, two bedrooms, two bathrooms, a kitchen, and an entrance hall. Heating and air-conditioning equipment is included. The kitchen is planned to have a refrigerator, washing machine and drier, sink, range, dishwashing machine, and waste-disposal unit.

The house is 36 ft in diameter, 22 ft high, and weighs 8000 lb. This compares with 150 tons for a frame house of 625 sq ft of floor space with foundation. Based upon present material and labor costs and an initial mass-production basis of 50,000 per year, the house, complete, erected, and ready for occupancy will sell for $6500.

Design of the circular house is based on the principle of supporting weight by tension and utilizing the great tensile strength of new lightweight metals for this purpose.

The entire house, including the floor, is suspended from a single central mast of stainless steel or main compression member and anchored to the ground by deep anchors. All the structural elements appended to this mast tend, because of the force of gravity, to cluster about the mast, giving cohesiveness to the whole structure.

When first designed, the tensile strength of available ma-

terials for the tension members was such that in order to support the necessary weight, the tension cables which hold up floor, walls, and roof had to be spread outside the walls of the house. However, the development of alloy steels of high tensile strength made it possible to flatten out the pitch of the tension members This is accomplished by the use of three "compression rings"—the smallest located at the top of the mast, a second larger one half way down the roof, and the third and largest forming the perimeter of the base of the roof.

The top ring is attached to the mast by criss-crossed (triangulated) tension rods (like spokes of a wheel.) This same triangulated construction connects the remaining compression rings, holds up the floor, and extends to the ground anchoring. Materials used in the prototype house included: aluminum, plexiglas, lucite, plastic screens, copper wire and tubing, plastic and rubberized fabric, synthetic rubber extrusions, fiber glass, plywood, stainless steel, cadmium plating, galvanized-steel strand cable, chrome-molybdenum steel, magnesium, and nylon.

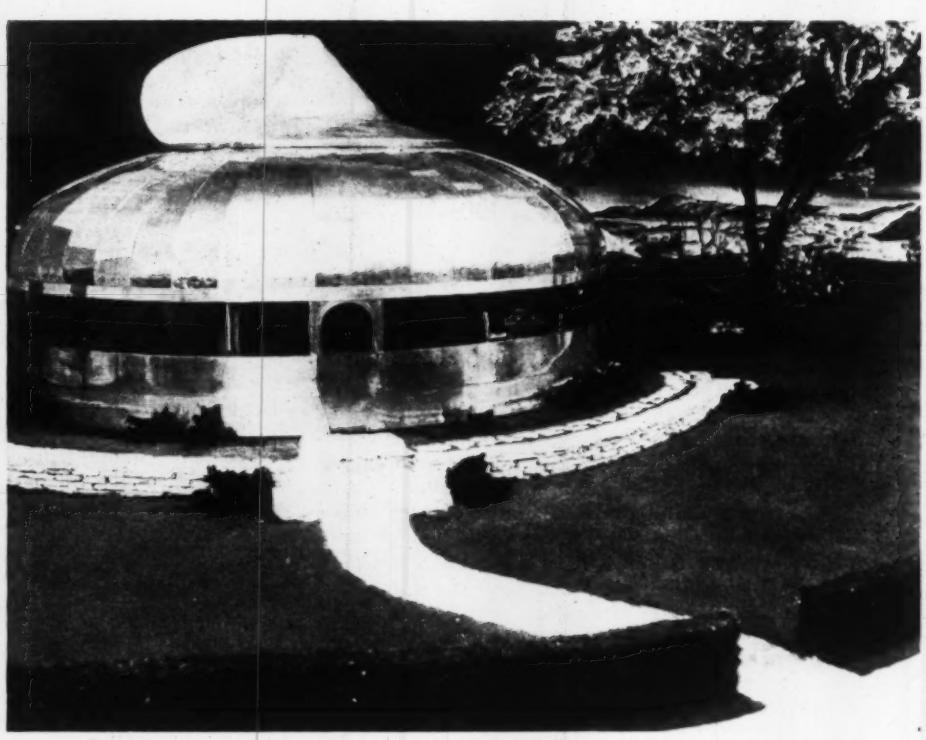

FIG. 5 A SCALE MODEL SHOWING THE HEMISPHERICAL HOUSE IN LANDSCAPED SETTING

The lower half of the round exterior wall of the house is a sheet cylinder of aluminum alloy; the upper half is clear plexiglas window. Below the window area sections of the aluminum may be lowered to reveal a plastic screen built into the wall of the house. A total of 240 sq ft of screen surface is provided and 320 sq ft of plexiglas window. The roof is composed of 48 metal sectors, or cowling gores stretched over the aluminum ribs. One or more layers of aluminum foil provide insulation. The ceiling and inside walls are also of aluminum, and the floor is made of impregnated plywood sections joined with aluminum strips, supported by aluminum beams.

All facilities are grouped in or around the central column for maximum efficiency. Interior walls radiate from the center.

The house is lightningproof through grounding, and it will withstand winds of hurricane force up to 180 mph.

A large ventilator, 18 ft in diameter, which rotates on the top of the house, employs outside air motion to accelerate interior dynamic fountain motion, thus providing excellent air conditioning.

The Fuller house has been designed not only for high performance as a human dwelling, but for maximum efficiency in mass production, transportation, and in assembly on site. A single cylindrical container 16 ft long and $4\frac{1}{2}$ ft in diameter will be used to ship the parts from the factory. Kitchen equipment will be crated and shipped separately by the manufacturers.

Once delivered, it takes only 160 man-hours to put up the house—two days' work for a 10-man crew. It is then ready for service connections. No inside plumbing, masonry, carpentry wiring, painting, or plastering is involved at the site.

Fuller Houses will be distributed, erected, and serviced along lines similar to the automobile industry. A nation-wide housing-service organization is now being set up—the start of a new industry. Permanent local dealers will maintain offices, showrooms, and sales, erecting, and service staffs. Dealers will operate under distributors in key marketing areas, with training by Fuller personnel.

Most Fuller Houses will go into planned community developments, with veterans having priority.

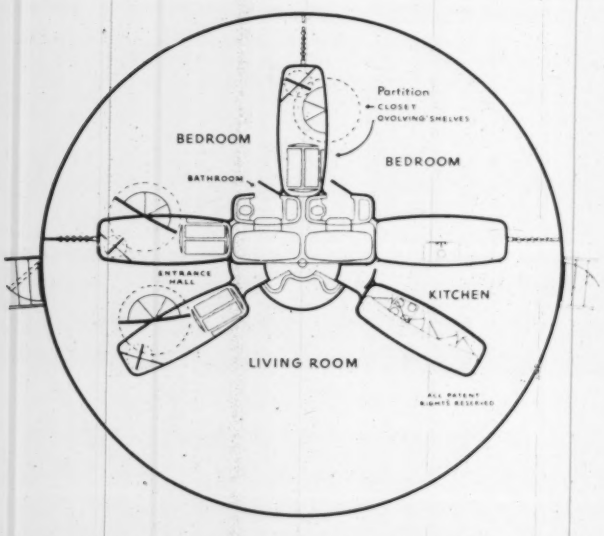

FIG. 6 FLOOR PLAN OF THE FULLER HOUSE

(The circular design reduces heat costs, cuts wind resistance, and affords greater area in a lightweight, rigid structure. Partitions contain all shelves and storage. Accordian folding doors and unit bathrooms save space, while revolving closet racks bring clothes out into the room.)

German Rubber Industry

IN spite of its pioneering work on synthetic rubber, the German rubber industry had not progressed relatively as far as the rubber industry in the United States in the use of their Buna-type synthetic rubbers. This was revealed by Earl W. Glen, Rubber Division, Civilian Production Administration, in a paper, "Observations of the German Rubber Industry," which he presented at the Society of Automotive Engineers' German Engineering Evaluation Meeting held March 4, 1946, in Detroit, Mich.

Due to this lack of progress, it was found that many tire and rubber-goods manufacturers were very critical of the Buna rubber that they were forced to use at the beginning of the war. Under this pressure, I. G. Farbenindustrie developed Buna S-3 which eliminated some of the production difficulties and improved the performance of rubber products, particularly tires.

The development by I. G. Farbenindustrie of Koresin for compounding with synthetic rubber to improve the tackiness facilitated tire and mechanical-goods production and was claimed to result in improved heat-performance of tires. In spite of these improvements Germany's rate of production of synthetic-rubber goods was far below that of the rubber industry in the United States. In this regard, it was fortunate that Germany's tire and rubber-goods requirements were relatively small. Another saving factor to them was the fact that labor was cheap, particularly after many slave laborers were placed in industry.

German technique of manufacture of synthetic-rubber goods was in most instances inferior to modern methods as used in the United States. This was particularly true in the truck-tire sizes, both in tire building and tire curing. Passenger-tire building machines were good and in most cases were duplicates of American machines of prewar design. In some cases improvements in the manufacture of specialty rubber goods were noted such as the calendering of gas-proof coated fabrics and large-scale continuous curing methods for all types of coated fabrics. Special note, however, should be made of the fact that conveyor-belt manufacturing equipment in the Continental Rubber Plant in Nordhafen was larger than any in existence anywhere else in the world and was capable of manufacturing and curing belts up to 3 meters wide.

German equipment for brass-plating metal goods to facilitate bonding synthetics to track blocks and bogie rollers were excellent. Note should also be made of the fact that an improved method of bonding these articles was in process of development in the I. G. Farbenindustrie Laboratories in Leverkusen wherein a coating of a new chemical called Desmodur R could be applied more efficiently than brass plating and produced a more uniform and more satisfactory bond.

Desmodur R was also used as a tire cord dip and general tackifier in the German tire industry and its qualities were so outstanding as an adhesive that samples are being shipped to this country for experimentation.

Other interesting products found in Germany were the Luka Reifen and Draftband Reifen. The Luka Reifen was a tire unit which performed the same function as our American Run-Flat tire construction and incorporated a cellular solid-rubber filler which replaced the inner tube. When placed inside of a regular truck tire, this unit was slightly in compression and was claimed to be very successful in operation without air. Its principal merit was that its manufacture was completely independent of that of the tire in which it was used and so production on tires could be maintained without the handicaps that were involved in our American production of the Run-Flat construction. Luka Reifens were not difficult to make and the ability to isolate their manufacture appeared to be of considerable advantage.

The Draftband Reifen was an interesting product in the form of a demountable feature accomplished by building a tire without a steel base band using bead wire embedded in a beveled hard-rubber base as the surface to mount on a beveled split rim. The tread surface on the tires was the conventional solid-tire type. Principal advantages of this type of unit were considerable simplification of shipping through ability to elongate the unit and elimination of the weight of the steel base band. In addition, the ability to dismount and change tires in the field was particularly advantageous. Performance on the Draftband Reifen was quoted as excellent and German tire engineers were looking forward to further development on this item to replace all types of solid tires in the postwar period.

More interesting than the regular tire plants were the experimental laboratories of the I. G. Farbenindustrie Synthetic Rubber Laboratory in Leverkusen. The laboratories, in addition to housing the fundamental research on improved synthetic rubber polymers, included a complete experimental tire-building plant capable of producing 80 to 100 tires each 8-hour shift. This experimental tire-building unit included machines for building tires all the way from passenger size to 13.50–20 large truck tires. Features of particular interest were the special individually powered rolls on mills and calenders to facilitate power-consumption studies on different types of synthetic rubbers. In addition to regular tire-building equipment, this experimental unit also included a tire-building unit within a controlled-atmosphere room which demonstrated that with synthetic rubber greater success in the elimination of production difficulties was obtained with temperatures less than 18 C and with relative humidity of less than 70 per cent. Study showed that with either temperature or humidity higher than these figures tackiness was reduced and welding properties in the tire-building operation were so low that considerable separation was experienced at the uncured tire expanding and bagging machine. All in all, this laboratory equipment was outstanding and represented a concentration of effort in the production of synthetics for tires and tire-building technique that were unexcelled even in the United States.

Special note should also be made of the fact that in the research physical-test laboratory in Leverkusen a special type of hysteresis analyzer was found. This was the same test unit observed in this laboratory in prewar days and it would appear from the results quoted that it had been of major assistance in the development of improved synthetic-rubber polymers. To summarize, it was indicated that the experimental work on synthetic rubbers at Leverkusen was very far advanced and at least on a par with the best that is being done anywhere.

No road-test fleets such as we know them in the United States were operated by even the larger German companies, though extensive laboratory equipment was found in numerous plants. The rubber industry was also denied the benefit of co-operative testing with the German Army and was placed in the position where it simply took orders from the Army and filled them. Only in very rare instances were tire designers from industry privileged to inspect tires removed from Army vehicles. As a result of this lack of co-operation, it can be said that the German rubber industry was in a large degree operating blindly, for it is a well-recognized principle in tire development that laboratory testing alone is not adequate. It was not strange therefore to learn from the engineers in the rubber industry that they were quite well satisfied with their wartime Buna-S type of tire.

The German rayon tire-cord fabric was also a very new product before the war and the possibility of development of better grades of rayon cord was limited almost immediately by the considerable demand for production. Thus we find tires made

of an inferior type of rayon yarn which required manufacture into a heavier-gage cord in order to stand up in fatigue. By comparison with rayon tire cord now used in the United States, rayon cord used in the German tires dates back almost 15 years. It was a completely inferior type of cord and yet German engineers, thinking of it only in terms of tensile strength, decided that average synthetic tires constructed of this heavier cord would be strong enough made with two plies less than prewar standard cotton-cord construction. That this left them with a comparably inferior type of tire has been confirmed by road tests here in the United States on tires evacuated from Germany by our group. All of these tires failed at very low mileage from separation, circumferential shoulder fatigue, and severe tread cracking. In addition to these tire tests other tires were built in the United States using German compounding materials and American-made rayon cord fabric. These tests proved that both the German tread recipe and Buna S-3 polymers produced excellent tread wear. In fact, tread-wear results using the German recipe and compounding materials in this test group of 9.00-20 tires were outstanding and indicated that we still have much work to do in this country on the development of improved synthetic-rubber polymers.

To summarize, it must be granted that Germany had done a comparatively good job on the development and use of synthetic rubber, considering all factors. Tire-design improvements and improvements in rayon tire-cord fabric quality would have made their tires much more serviceable and would have left only the very difficult production bottleneck in milling to contend with. It is this latter difficulty that makes us here in the United States more proud of our own synthetic in that it enabled us to accomplish the major task of supplying all our military and civilian tire and rubber needs during our critical wartime period with rubber products that did a much better job in spite of our relative lack of prewar experience with synthetics.

Furniture Manufacture

IN a paper entitled, "Unique Methods Used in the Manufacture of Furniture," which he read before a Wood Industries technical session during the 1945 A.S.M.E. Annual Meeting, Roger R. Smith, member A.S.M.E., treasurer, L. B. Ramsdell Co., Gardner, Mass., told how his company planned to meet problems such as making new and special-purpose machines with which to reduce the amount of necessary labor in a product, developing acceptable substitute materials, and creating new products, which would be new in use as well as design.

"Any company," said Mr. Smith, "in business over a period of time is bound to accumulate machinery originally acquired for a specific purpose and subsequently adapted to other uses. It is bound to have antiquated machinery which should have have been scrapped years ago."

Most of the paper is devoted to the discussion of the unique equipment used in the manufacture of juvenile furniture. For instance, a planer, to rough-dress dimension stock as it came from the kiln, was wanted. The company had a 1910 Whitney 24-in. double surfacer, model P-6. After the machine was reconditioned the heads were motorized. Swinging bases with V-belts were used to obtain a short drive and to reduce tension in so far as possible on cylinder bearings. It's square heads seemed to lend themselves to rough-dressing stock that varied from one inch to one and one-half inches in thickness without adjustment. A section of roll conveyer was bolted onto the delivery end so that the stock traveled directly to a chain-fed ripsaw which culled out defects.

To gain elevation a section of canvas belt conveyer delivers the stock from the ripsaw to another conveyer, thence to a jointer. The jointer was rebuilt, motorized, and the travel of its chain reversed, making it a left-hand machine so that the operator could stand on it's right side. The stock thus travels through one side on one edge, is mechanically turned over to be jointed on the other edge, and is delivered to the hopper feed mechanism of a Plycore continuous glue clamp. Four rows of $18\frac{1}{2}$-in. stock can be run through the Plycore clamp.

Delivery of the glued-up blanks on a belt conveyer to a finishing double surfacer completes the mill-room preparation of chair-rest blanks. This arrangement of machines employs eight operators and is capable of 12,000 fbm per 8 hr.

Many other unique manufacturing methods combining the use of old and new-machinery, were described by Mr. Smith. He also predicted that "countless changes in the furniture industry were to be expected. With higher cutting speeds made possible by electrical frequencies of 400 cycles and better ball bearings, there will come improved cutters which will require less frequent sharpening. Carbide tools will become as common to woodworking establishments as they are to machine shops. Adhesives will be accelerated in drying time so that gluing will be just a passing operation. Kiln-drying may be done on a belt conveyer as the lumber is unloaded from the car. Hot lacquer will permit a heavier coat per application, consequently less operations. Electronic controls will make painting an automatic operation with high-frequency currents serving to remove and recover the excess material."

Metal Coating

IN an article, "The Use of Ultra Sound in Metal Coating," published in the January issue of *Products Finishing*, Charles D. Townsend, member A.S.M.E., process engineer, S. K. Wellman Company, Cleveland, Ohio, reveals that research work has been carried on using ultra sound frequencies to coat metal parts. Experiments indicate the possibilities and outline one particular example of this use of high-frequency electrical energy. Tests have been made successfully in the molten-tinning of aluminum sheet.

It is recalled that the surface oxides on aluminum make it practically impossible to apply any type of metal coating. Dip-tinning and attempts at soldering have not been successful to any great extent. However, under the recently developed process, aluminum can be coated with tin and the bonding of this coating is not separated by the oxide.

The process consists of dipping the aluminum into a molten bath of tin and at the same time applying ultra sound waves to the aluminum and tin alternately. The rapid vibrations cause the oxides on the surface to be removed and replaced by a layer of tin which alloys with the surface of the aluminum.

The frequency of ultra sound waves is 300,000 vibrations per second, causing metal particles to obtain a velocity of 15.6 in per sec with an amplitude of about 0.000039 in. Since the resultant acceleration is 10,000 times the acceleration due to gravity, this, no doubt, accounts for the removal of the oxide film from the aluminum. The tin particles will hammer the surface and thus actually remove the film by this bombardment.

The wave lengths of ultra sound approach those of visible light waves, and in liquids the velocity of sound is 3900 ft per sec with wave lengths from 2.3 to 0.00008 in. Due to this fact, very high pressure gradients of about 382 lb per in. are set up and impart enormous accelerations to particles in the liquid medium. In solids, this acceleration may cause complete disintegration of the mass. However, if controlled, it can be used to improve the structure of cast materials.

While the possibilities of the use of ultra sound waves for

metal coating have not been explored to any extent the process is impressive, but further tests must be made to prove it is completely practical. There are many uses where this process might be employed to great advantage.

Aluminum and many of its alloys have long been recognized in the electrical field but the difficulty encountered in soldering has hindered its use in many instances.

With this recent development the tinned sheet of aluminum can be used for lugs in many electrical connections. In addition, many parts now made from brass, bronze, and nickel silver could be replaced by tinned aluminum sheet. By the use of this material practically no flux would be required for soldering and this, it is believed, would overcome many difficulties that are now encountered.

Carrying the use of ultra sound a little further, it might be possible to apply aluminum coating to steel by this method, thereby opening many new uses for such a metal combination. Ultra sound waves and their use in the metal-coating industry are now established, and it remains for engineers to develop their further use. The use of high-frequency electrical energy and sound waves should help in the improvement of the present methods used in metal coating.

British Aircraft Engines

Goblin Engine

DESIGN of what is known as the Goblin jet-propulsion engine began in April, 1941, by The de Havilland Aircraft Company, Limited, Edgeware, England. This came about as a result of the early successes achieved by Air Commodore F. Whittle, with the jet-propulsion gas turbine.

An illustrated article in the Feb. 22, 1946, issue of *Engineering* reveals some of the essentials and technical details of the Goblin engine as it was developed by de Havilland. In January, 1944, Goblin engines, which had been sent to the United States, were flying in the Lockheed Shooting Star prototype, and by the spring of 1944 this machine and also the new de Havilland Vampire, in their respective countries, were exceeding all previous speed records by flying at more than 500 mph.

It is of interest to trace the changes that take place as the air passes through the engine. Drawn into the compressor at the atmospheric pressure of 30 in. Hg and a temperature of 288 C abs, the air is accelerated to a velocity of about 1400 ft per sec at the blade tips. In the diffuser, most of the velocity energy is converted to pressure energy and the air leaves at a velocity of about 200 ft per sec, the pressure being 102 in. Hg and the temperature 440 C abs. The compressor can be seen from these figures to have a compression ratio of 3.4 to 1. About 20 per cent of the air entering each combustion chamber is primary air into which the oil fuel is sprayed and burned. The remainder of the air is added progressively and the resultant temperature of the gases entering the turbine nozzle chamber is 1100 C abs. The turbine is not of the pure impulse type, there being some drop of gas pressure with the corresponding reaction effect, in the moving blades of the rotor. The gas pressure is reduced from 102 in. Hg to 37 in. Hg in the turbine, accompanied by a fall of temperature in accord with the heat-energy release to the compressor shaft. In the convergent jet pipe the residual pressure energy corresponding to the difference between 27 in. Hg and 30 in. Hg is converted to velocity energy, and the gases leave the jet at a velocity of about 1600 ft per sec as already stated.

Some idea of the horsepower developed by the turbine and expended in the compressor can be obtained from considering the performance of the latter. Assuming an air intake of 60 lb per sec and an adiabatic efficiency of 80 per cent, the work of adiabatic compression to 3.4 times the original pressure represents an expenditure of rather more than 5450 hp. The jet-propulsion unit as such develops thrust and not horsepower, but the equivalent horsepower can be calculated if the aircraft speed is known. At take-off, that is, before acquiring any forward speed, the engine develops, theoretically, no horse power. The output from a conventional propeller engine may, however, be expressed in terms of thrust per horsepower. A conservative value would be about 3 lb thrust per horsepower. The Goblin is therefore equivalent to a 1000 hp engine at zero forward speed. On the other hand, at a flying speed of 600 mph (880 ft per sec), the thrust is approximately 3500 lb and the horsepower corresponding to such a thrust is 5100, which exceeds anything obtainable at present from an engine of the reciprocating type. In this connection it is of interest to note that the Vampire aircraft, fitted with a Goblin jet-propulsion engine, is able to take off from an aircraft carrier without rocket or catapult assistance. It is also able to land on the deck of a carrier though, as is well known, the jet-propulsion unit continues to develop a thrust of 100 lb to 200 lb even at idling speeds, and this increases the difficulty of arresting the motion of the machine with the brakes or by any other method.

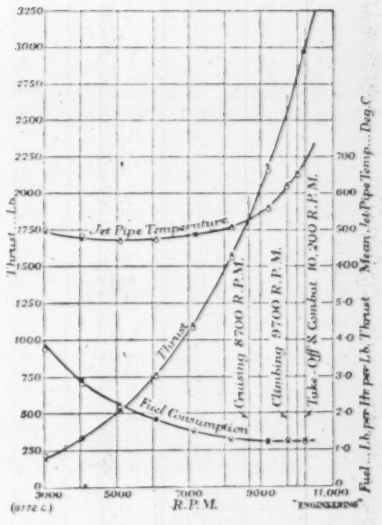

FIG. 7 CHARACTERISTIC CURVES FOR A RECENTLY CONSTRUCTED GOBLIN JET-PROPULSION ENGINE

The thrust, jet-pipe temperature, and specific fuel consumption vary with the speed in revolutions per minute of the turbo-compressor unit, and Fig. 7 gives the characteristic curves for a recently constructed Goblin engine, these being obtained on a stationary test bed under ground-level conditions. The fuel used in the Goblin engine is paraffin.

Nene and Derwent Engines

In a paper which he read before the Sixtieth Annual General and Professional Meeting of The Engineering Institute of Canada, on Feb. 7, 1946, J. D. Pearson, chief technical services engineer, Rolls-Royce Group, England, presented the performance and installation characteristics of the jet-propulsion gas turbine from the point of view of the aircraft man. In order to assist in this, comparisons were made of its performance and installation characteristics with those of the familiar piston-engine-propeller combination. The two engines used to make the comparison were the Rolls-Royce Nene and Derwent V.

The basic design of these engines is also based on Air Commodore Whittle's original design, as are all of the jet-propelled aircraft engines now in production in England and the United States.

Rolls-Royce first took an interest in jet-propulsion units for aircraft in 1938, and in 1939 the first design projects were made. The first Rolls-Royce version was the Welland which was

tested in the Wellington, one of the famous early wartime bombers. These Whittle-type units were also supplied for test purposes in other aircraft, including the Meteor.

In April, 1943, Rolls-Royce began to design a further development of an improved type, called the Derwent, which was the first British jet engine to go into quantity production, as well as the first jet engine to power British aircraft in operational service with the Royal Air Force.

To give some idea of the rapid development achieved by Rolls-Royce, the original Weiland engine fitted to the Meteor aircraft gave 1600 lb thrust and weighed 850 lb. The Derwent V, which is now being fitted to the same aircraft and which is of exactly the same over-all diameter, gives 3500 lb thrust for weight of 1250 lb. The specific fuel consumption per pound of thrust has also been improved.

During the same period a larger engine, the Nene, which gives 5000 lb thrust for a weight of 1600 lb, was developed.

In comparing the jet-engine performance of the Nene with the Merlin, a piston-engine-propeller combination, the following facts were revealed by Mr. Pearson:

Performance on the test bed showed that down from full thrust to half thrust the fuel consumption of the jet engine rises only about five per cent, but below half power the rise in specific consumption becomes greater. This characteristic differentiates the jet engine from the piston engine in that the optimum specific fuel consumption occurs at close to maximum power.

A comparison of thrust and horsepower against altitude showed that the Nene gave more than two and one half times the Merlin thrust horsepower at sea level and just under twice its power at 40,000 ft.

At high forward speeds the jet engine developed enormous power while the propeller type was deficient at similar conditions.

When comparing thrust and fuel consumption with forward speed it is found that as the jet engine's forward speed increases there is relatively small increase in fuel consumption per pound per hour. On the other hand, the piston-engine fuel consumption, expressed in the same terms, begins to increase rapidly over 450 mph due to the rapid decrease in propeller efficiency.

A comparison of the cruising thrust and fuel consumption with altitude at 400 mph showed that, whereas the specific consumption of the Merlin fell off with increasing altitude, particularly after the full-throttle height was reached, the specific consumption of the Nene actually fell progressively with the increasing altitude. The Nene thrust falls off with altitude while the Merlin thrust increases slightly.

The entire text of Mr. Pearson's paper appears in the March, 1946, issue of *The Engineering Journal*. An article on page 252 of the March issue of MECHANICAL ENGINEERING entitled, "New Engines—New Speeds," which was abstracted from *Engineering*, Nov. 16, 1945, describes the general arrangement of the Rolls-Royce "Derwent."

New Boxes From Old

A PRACTICAL production line for cutting up old wooden boxes and making new ones from the boards on an efficient cost-saving basis is outlined by V. A. Dash, production analyst, New York, N. Y., in the January issue of *Food Industries*. This technique was developed because a certain wartime packaging operation needed large quantities of boxes. These were difficult to obtain at the time, but a great supply of old boxes of all sizes and types was available so a simple production line was set up to make the new from the old.

That the operation was successful—and therefore of interest to manufacturers who use wooden boxes—is proved by the 45-cent average cost of a rebuilt box, compared with a price of $1.35 for a new container. The 45 cent figure is based on 80-cents-per-hour labor, no charge for the old boxes, and no rent. It includes power, maintenance, and other costs.

Referring to the flow diagram, Fig. 8, the old boxes are brought to the cutoff saw on a roller conveyer Each box is cut-off as near one end as the nails will permit. Then it is sawed at the other end at a point which gives the length of boards required. Some of the boxes will be too large to handle on the cutoff saw at this point so these must be dismantled and the usable pieces thrown into boxes on the conveyer.

A special tool was devised for the dismantling operation consisting of a 2-ft pinch bar, with the gooseneck removed, and a 4 × 6-in. five-sided plate welded to the heel of the prying foot. A fairly sharp chisel edge is ground on the ends and slanting edges of the foot for insertion into the cracks after they are started. The foot gives sufficient lift, when the tool is rammed into one corner and along the end, to remove the nails from their seats.

After the boxes and the dismantled boards have been cut to length on the cutoff saw, the pieces needing separation and denailing (such as side and bottom pieces that are nailed together) are placed on a truck at the denailing table. The ends of the boxes are thrown into a scrap pile.

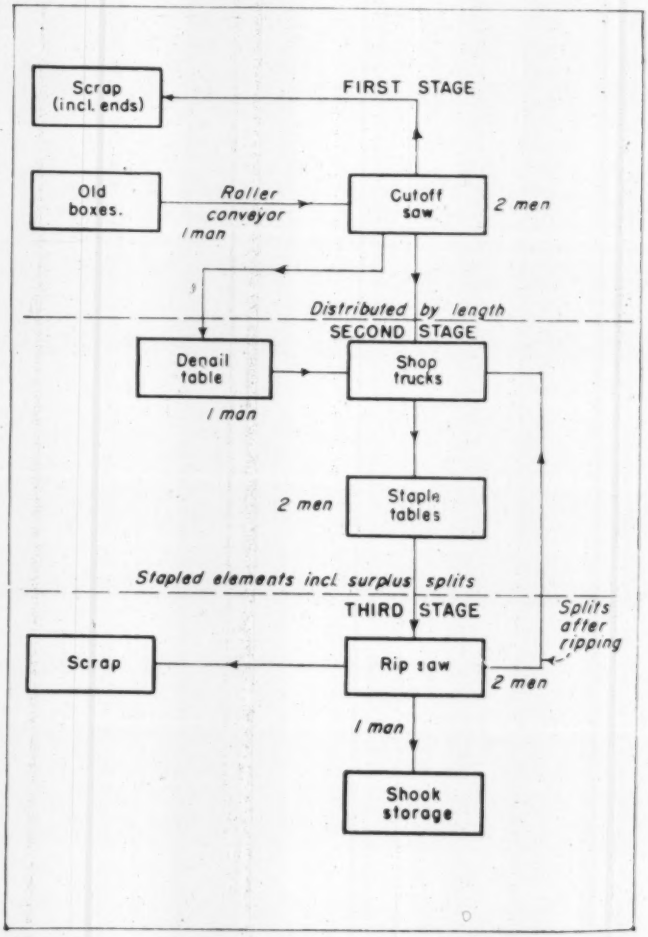

FIG. 8 FLOW DIAGRAM OF OPERATIONS INVOLVED IN MAKING NEW BOXES FROM OLD

(Three work stages for a three-man crew which moves from stage to stage as the work progresses are shown.)

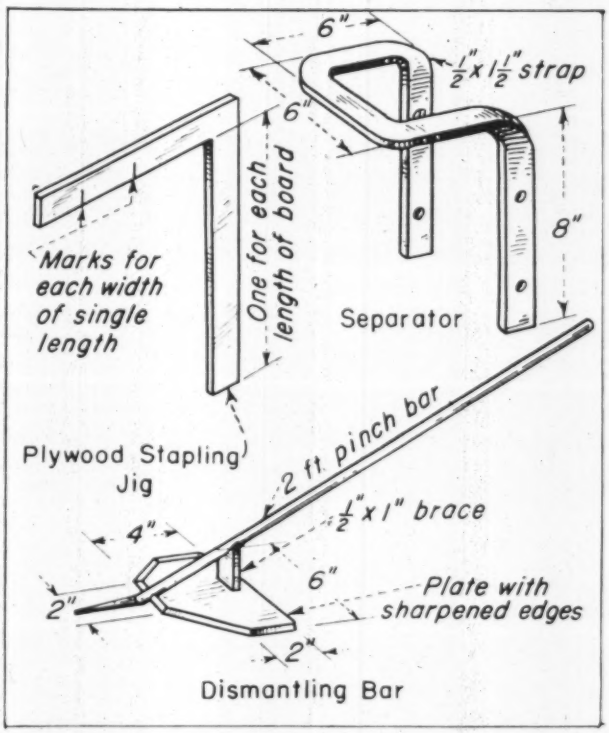

FIG. 9 THREE SPECIAL TOOLS WHICH SIMPLIFY OPERATIONS

On a post of the denailing table is mounted a separator, another specially developed tool, which in reality is a simple, heavy modification of the old-fashioned mud scraper. By placing the side board of the old box bottom at a slight angle on the separator and pushing strongly, the separator is forced into the crack, and downward pressure starts the separation. The material is then shifted so that a corner of the separator is between, or next to, stubborn nails. After denailing, the pieces are distributed to appropriate trucks according to their length and moved to stapling tables.

Still another special device is an L-shaped plywood jig on the stapling tables. One arm of this jig is the exact length of the board required. On the other arm is marked the width of the piece desired. If one board is not wide enough, a second or third is placed alongside until the last one overlaps the width mark. These are then stapled together to form a new box element. Since it is to be trimmed, the last board may have a split or bad edge.

Elements of the same width are stacked separately on a truck and taken to a ripsaw to be cut to exact width. Surplus boards with bad edges are placed on one end of the truck, and at the ripsaw the bad edges are cut off and the pieces returned to the stapling table.

After the stapled elements are ripped to exact width, they are trucked to appropriate piles in the storage area, ready for assembly into new boxes. A sander behind the ripsaw will produce new-appearing boxes at slight cost.

Personnel needed varies from 3 to 13, depending upon the output required. A labor force of 13 has produced 200 sets of box shooks a day.

If only 3 men are employed the work could be done in the following three steps: (1) One would work on the old-box conveyer and two on the cutoff saw, (2) one on the denailing table and two on the stapling table, (3) two on the rip-saw and one on shook storage.

To turn out complete boxes a crew of nailers would be required in addition.

Coal-Burning Gas Turbine

THE virtually inexhaustible coal reserves of the United States and the high theoretical thermal efficiency of the gas turbine have encouraged some of the American railroads and Bituminous Coal Research, Incorporated, to sponsor research on the application of coal as a fuel for the gas turbine.

How far this research has already progressed was indicated by John I. Yellott, member A.S.M.E., director of research, Locomotive Development Committee, during the presentation of a paper, "The Coal-Burning Gas Turbine," before a meeting of the Fuels Division of the Metropolitan Section, A.S.M.E., New York, N. Y., Feb. 5, 1946.

With the aid of operating data from a large eastern railroad, Mr. Yellott compared the economics of a Diesel passenger locomotive operating approximately 260,000 miles a year at a cost per mile of 22.27 cents against the hypothetical operating costs of an equivalent coal-burning gas-turbine locomotive and showed that operating costs could be cut to 7.96 cents per mile. Since the third man on the Diesel would not be required aboard the coal-burning turbomotive and since the same electrical maintenance could be expected for both, Mr. Yellott predicted that the turbomotive could expect mechanical transmission with higher efficiency, lower first cost, and less upkeep.

Three major problems impede the application of coal as a fuel for the gas turbine. The first of these is the preparation of the coal for combustion. Coal must be transported from the bunker, pulverized to the smallest practical particle size, and fed to the combustor at a controlled rate.

Space limitations impose the second major problem, the magnitude of which is emphasized by the fact that there is today no pulverized-coal-burning locomotive in operation. Finally, the problem of fly ash in the products of combustion must be solved before the coal-burning gas turbine can be considered a practical prime mover.

In attacking the problem of coal preparation, the Locomotive Development Committee proposed a coal-handling system designed to convey coal from the bunker by a special type of screw feeder which takes coal along the length of the bunker, thus eliminating virtually all of the dead spots and permitting a uniform lowering of the bunker level. Rate of coal flow is accomplished simply by varying the speed of the driving device. By the introduction of waste hot air into the trough along which the coal moves, drying is started as soon as the coal leaves the bunker. Clean-out plates are provided through which the screw feeder rejects tramp iron.

The first step in coal preparation for the "coal atomizer" used by the Locomotive Development Committee involves crushing the coal to reduce it to a minus-10-mesh size. This is readily accomplished by use of a simple hammermill. The coal is then further dried and conveyed to the pressure tank from which it is fed to the coal atomizer.

COAL ATOMIZER

The "coal atomizer," shown in Fig. 11, operates on the continuous-explosion principle. The crushed coal in the pulverizer tank is subjected to high air pressure and the pores of the coal particles become filled with the compressed air. By causing the coal to pass through a nozzle, where the pressure falls instantaneously, the particles are shattered by the sudden release of the entrapped air. If the feed particles are smaller than one third of the throat diameter of the nozzle, clogging will not occur. About one pound of air per pound of coal is necessary for

pulverization to such a fineness that more than 50 per cent of the product will pass a 200-mesh screen. By adding a simple attrition device, called a "cyclonizer," the fineness can be increased until 80 per cent passes through a 325-mesh screen.

COMBUSTION PROBLEM

While attainable heat release in pressurized combustion is still a matter of conjecture, current investigations of combustor design are based on the acknowledged necessity of producing a maximum of relative motion between the burning coal particle and the surrounding air. Investigations by the Fuel Research Board in England have revealed that heat releases in excess of 500,000 Btu per cu ft of combustion space can be obtained in the "Vor Tex" combustor. The principle of this design is the maintenance of a rotating ring of pulverized coal through which the air passes on its way from tangential inlets to the central outlet. The coal particles tend by centrifugal force to fly outward, while the inward drag of the air resists the centrifugal force and ultimately, when they are burned down to a sufficiently small size, carries the burned-out particles through the central outlet.

Fundamental studies of the burning of pulverized coal under pressure are being conducted at the Battelle Memorial Institute on behalf of the Locomotive Development Committee and indications have already been obtained that the application of pressure shortens the pulverized-coal flame materially. Combustion rates for finely pulverized coal may soon approach those of the oil now being burned in jet-propelled aircraft.

FLY-ASH REMOVAL

Two important facts about fly ash promise ultimate solution of the fly-ash problem: (1) Electromicroscopic studies of fly ash at magnifications of 2600 diameters reveal that most of the fly-ash particles are nearly perfect spheres with diameters in the vicinity of 10 microns. (One micron is equal to one thousandth of a millimeter.) (2) Abrasion studies on gas-turbine blades show that particles in the gas stream smaller than 5 microns are relatively harmless to the gas-turbine blade material. One of the problems of burning pulverized coal as fuel for the gas turbine therefore appears to be the removal of all ash particles larger than 5 microns in diameter.

In its study of the art of dust collection, the attention of the Locomotive Development Committee was called to a type of separator developed by the Aerotec Company for use as an intake-air filter on airplanes and tanks for desert service. At 70 F this two-inch cyclone had demonstrated its ability to remove virtually all particles larger than 10 microns, and to eliminate about 80 per cent in the 5-micron size range. Repeated tests with the Aerotec filter indicated that a battery of these filters behave in quite the same manner as an individual filter. Design calculations show that a battery of filters in a 5000-hp installation would produce from 360 to 720 lb of fly ash per hr. Tests are being run to determine the suitability of this fly ash for rail sanding.

While the three major problems of the coal-burning gas turbine are well on the way to solution, the matter of control is still listed at this stage of research among the unsolved problems. Mr. Yellott feels that the recirculating type of control will give the necessary accuracy which would be difficult to attain with a screw feeder alone.

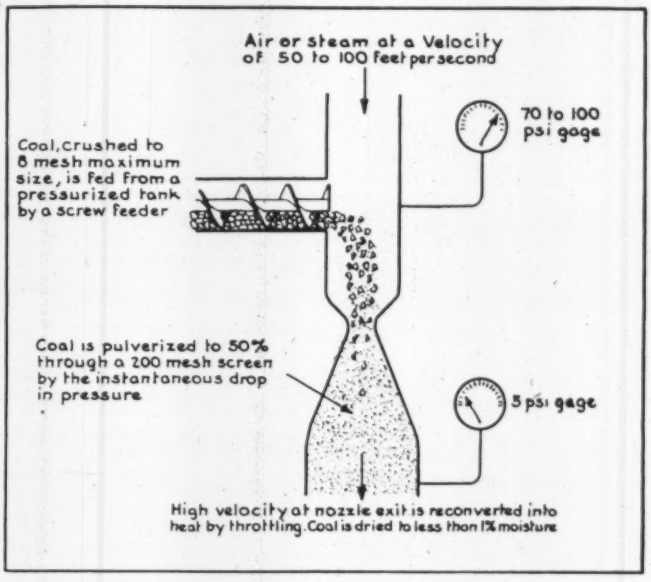
Air or steam at a Velocity of 50 to 100 feet per second
70 to 100 psi gage
Coal, crushed to 8 mesh maximum size, is fed from a pressurized tank by a screw feeder
Coal is pulverized to 50% through a 200 mesh screen by the instantaneous drop in pressure
5 psi gage
High velocity at nozzle exit is reconverted into heat by throttling. Coal is dried to less than 1% moisture

FIG. 11 PRINCIPLE OF OPERATION OF THE "COAL ATOMIZER"

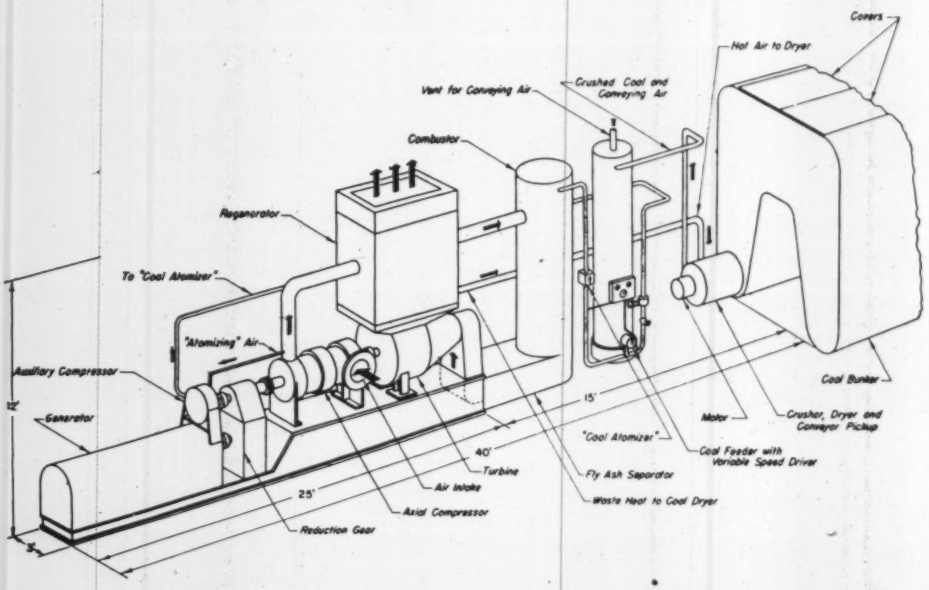

FIG. 10 COAL-BURNING GAS TURBINE FOR LOCOMOTIVE SERVICE

Precision Casting

OVER thirty editors and writers of technical and trade magazines were the guests of the Haynes Stellite Company on March 18 and 19 at their plant at Kokomo, Ind. The occasion was the release of information on the use of Hastelloy castings and Stellite, developed during the war and now applicable to industrial needs. Various officials and department heads gave thorough and interesting talks on the work that had been done as a contribution to the war effort, and a trip through the plant served to demonstrate the lost-wax process and the contribution this process had made to the war effort. The talks were high-lighted by a discussion on the future of research by Russell Franks, Union Carbide and Carbon Research Laboratories Incorporated, and by H. C. Cross, Battelle Memorial Institute, who discussed the co-operation between research and industry.

The discussions brought out quite definitely the field in which both Hastelloy castings and Stellite were applicable. It was emphasized that this field did not encroach upon that of other established metals, but rather filled in a definite gap. It is expected that the development of these materials will find even greater use in peacetime industry than under wartime conditions.

E. E. LeVan, president of the Haynes Stellite Company, pointed out that the industrial population of Kokomo had increased to a point slightly beyond that of the past few years and prophesied a considerable industrial expansion.

Hastelloy castings find their application where noncorrosive materials highly resistant to acids are required. The various Hastelloy alloys are given severe corrosion tests for any particular set of conditions and recommendations for a specific alloy are based on these tests.

Stellite was originally developed for use as table cutlery and pocket knives, and the lost-wax process was adopted from the dental industry where it had been used for forming bridges and dentures. When the need for mass production of intricate shapes developed because of the demand for military equipment, it was found that the lost-wax process could be applied to the castings of Stellite into forms and shapes that were extremely difficult to machine, and consequently could not be produced in sufficient quantities to meet the demand.

An example of the benefit derived by applying the lost-wax process is illustrated in the slide for a high-speed cloth-cutting machine, Fig. 12. Before the war this slide had been machined from bar stock in 42 operations, then heat-treated and finished by four grinding operations. By using Stellite and the lost-wax process, machining was reduced to four grinding operations and heat-treating was eliminated. Production has vastly increased and the cost of the slide was reduced by one half. The life of the Stellite slide was approximately three times that of the original slide.

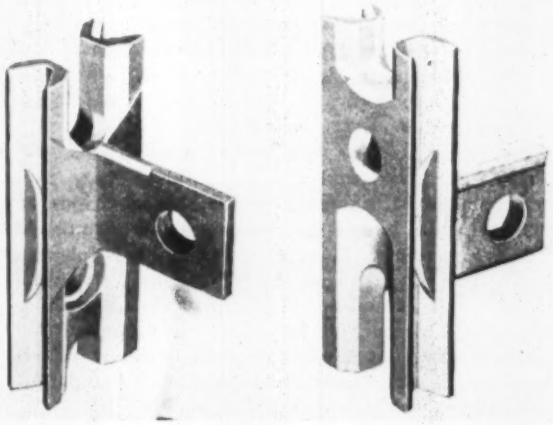

FIG. 12 USING STELLITE AND THE LOST-WAX PROCESS REDUCED MACHINING OPERATIONS ON THIS SLIDE FROM 42 TO 4 OPERATIONS

Another field in which the lost-wax process was used effectively was the production of supercharger buckets. Because of the difficulty in machining these buckets in the various shapes and sizes required, the lost-wax process was resorted to with the result that 2,100,000 supercharger buckets were produced in a single month at the peak of production.

The use of Stellite as a cutting material goes back to the first world war, during which it was found that production could be highly increased through its use for machine tools. With this background, a great deal of research work has gone into the development and improvement of this material to keep it in step with the development of new metals and machine procedures. It is found that Stellite works to best advantage on cast iron at speeds of from 70 to 150 feet per minute with feeds up to $^1/_8$ in.

Stellite is also used successfully for turning, facing, and boring operations on steel and for facing milling cutters. To use Stellite successfully a high degree of rigidity is necessary in order to take advantage of the cutting qualities of the tool; however, Stellite is not recommended for such operations as tapping, hobbing, and threading. The milling of steel with Stellite also is not generally recommended.

The Haynes Stellite Company has reduced the lost-wax process to a production basis and this procedure will be expanded in the future. A soft metal mold is made from the pattern and this mold encased in a steel frame to give it strength. Hot wax is injected into the mold in which the necessary cores have been placed so that an exact reproduction of the required part is obtained. The necessary allowance is made for the shrinkage of both the wax and the Stellite so that the finished product is true to size. A number of these wax parts are attached to gates and risers—the number depending upon the size and shape of the part to be cast. It is at this point that the assembly line comes into use. A standard riser developed for each type of casting is placed on a moving belt, and as it progresses down the line the parts are added, until each riser holds the required number. The entire assembly is then coated with a fine silica material held in suspension in a suitable liquid bond and this coating is built up in thickness by dusting or spraying. The first coating given the assembly insures a smooth inside finish. The assembly is then placed in a metal cylinder surrounded by a paper wrapper, which doubles the height of the cylinder and the whole thing is passed through a dehumidifying furnace to insure absolute dryness. The investment of the assembly with the mold material is carefully done to avoid disturbing any of the assembly parts, and also to prevent, in so far as possible, the inclusion of air pockets. The investing is carried out on a vibrating table which eliminates some of the air and also insures close contact between the investment and the molds. When filled to the top of the paper shell, the cylinder is placed on another vibrating table where it remains until all air has been worked free.

The investment is a chemically hardened mixture and the shell is set aside until this hardening process is complete, after which the paper shell is removed and the extra material sawed away. The weight of this extra material is depended on to exert sufficient pressure during the investment process to form the necessary contact between the mold and the investment material and to maintain this pressure during the hardening process.

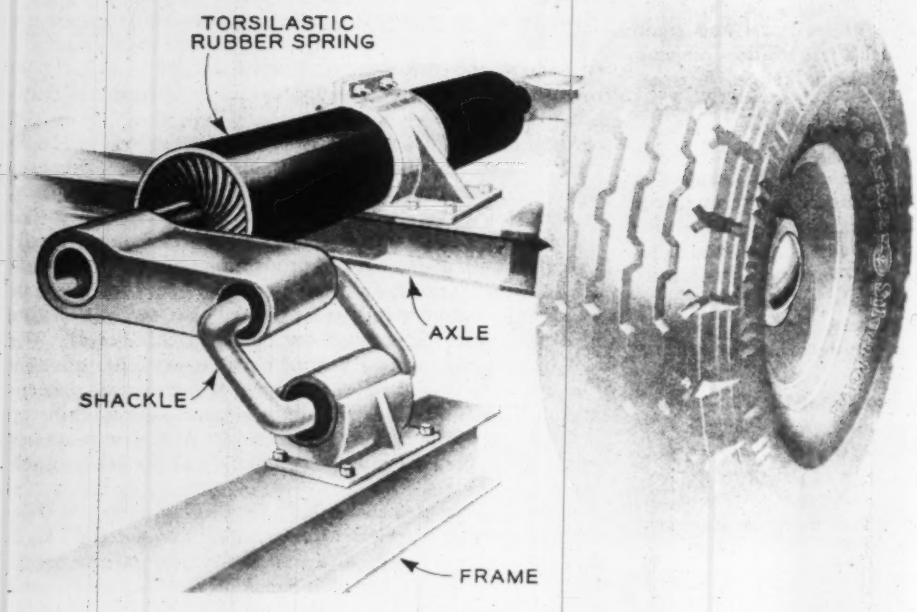

FIG. 13 PHOTO DIAGRAM OF TWIN-COACH TYPE OF INSTALLATION OF THE TORSILASTIC RUBBER SPRING
(Twisting of the rubber accomplishes the springing action.)

Each mold is carefully weighed to determine the exact amount of Stellite necessary to fill the cavity occupied by the wax and this material is heated in an electric furnace while the mold is passing through a furnace in which the major portion of the wax is melted out and the remainder is burned out due to the high temperature of the furnace. This temperature approaches 2000 F at the exit end.

Careful co-ordination between the temperature of the mold as it leaves the furnace and the temperature of the Stellite must be maintained, since these factors control to a considerable extent the grain size of the casting. Immediately upon leaving the furnace the mold is clamped to the Stellite furnace and the whole inverted. Sufficient air pressure is then applied above the molten Stellite to insure its completely filling all voids.

The lost-wax process is being used successfully for castings up to a weight of 5 lb, though at the present time a maximum of $3\frac{1}{2}$ lb to 4 lb is preferred. It is expected, however, that the general size of castings made by this process can be increased as the technique is perfected and larger castings are required.

Test bars, having approximately $\frac{1}{4}$-in. cross section, are cast and these test bars are broken at high temperatures as a check on the product. Since one of the principal attributes of Stellite is its operation at temperatures around 1500 F, it is also necessary to break the test bars at this high temperature. In order to do this it was necessary to equip the testing machine with Stellite tips into which the test bar is screwed. When assembled, the test bar and tips are inserted in an electric furnace where the temperature of the entire assembly is brought up to the required point. A careful check on heat control is made throughout this heating period so that the correct temperature is maintained.

During the development period castings are made using different gating arrangements and these castings are examined either by x ray or gamma ray in order to determine the procedure which will eliminate any internal stresses. Once the method of gating has been established, the part is put into production. Spot inspection during production is carried on.

During production, all Stellite castings are first given a visual inspection which is followed by a Zyglow inspection. This, in turn, is followed by the x-ray or gamma-ray inspection, thus insuring a high degree of perfection in the finished product.

Torsilastic Rubber Spring

A DISCUSSION of the use of rubber and synthetic rubber for mountings or suspensions in passenger cars is presented in a paper, "The Torsilastic Rubber Spring," by A. S. Krotz, chief development engineer, The B. F. Goodrich Company, Akron, Ohio.

Advantages claimed for the torsion spring are not only its characteristics as a spring but also in the flexibility of application which makes it possible to meet a wide range of requirements by variations in spring design and in the length of the moment arm which applies the torsional load.

The "torsilastic" spring is a torsion-type spring having an inner shaft, an outer metal shell, and a cylinder of rubber bonded to shaft and shell. A rubber spring assembly of this type containing 3.3 lb of rubber replaced a highly stressed coil spring weighing 11.5 lb. The shaft or inner tube weighs 3.69 lb, and the outer shell weighs 3.75 lb, total weight being 10.74 lb. As compared with the steel spring this weight represents the spring itself, the spring seats and mountings, and the support arm bearings.

The torsilastic spring eliminates bearings which would otherwise be necessary, and effectively insulates the road wheels from the chassis. It is said that under these conditions the torsilastic spring can be so applied in the chassis as to obtain the following advantages: There are no bearings to be lubricated or serviced; there is no abrasion, rust, or wearing-action from dirt, water, or mud; it will not develop squeaks or rattles; it is clean, lightweight, simple in design; it eliminates friction, and reduces vibrations; it has long service life, absorbs shock or impact from all directions, and reduces noise level; there is no danger of sudden failure; it provides a soft elastic ride; and it suspends chassis in a cushion of rubber thus furnishing complete rubber insulation.

The spring discussed in the paper is typical in design for the

front suspension of a 3400-lb car. It was road-tested in an automobile for 2½ years and no adjustment or service of any kind was necessary, although the car was somewhat high when the springs were installed and is now approximately ½ in. low. During the 2½ years the vehicle traveled more than 36,000 miles and had extremely rough handling.

A characteristic of these rubber springs which is not easily determined is the life of the unit. In attempting to forecast actual service life by means of accelerated fatigue tests, it is first necessary to emphasize the extremely wide difference between steel and rubber as elastic materials. Any acceleration in the normal flow of energy through a spring may reasonably be expected to have an exaggerated effect on rubber as compared with steel. This is substantiated by all available test data.

Any required laboratory fatigue life may be obtained with torsilastic springs. Accelerated laboratory tests as well as road tests have been used in establishing basic design limitations which will give spring life equivalent to maximum car life without wasting material.

In any of the designs thus far considered there is very little exposed surface of rubber and any deterioration at these exposed ends has been found to have a negligible effect on spring life. It has not been found necessary to use a shield of any kind at the ends, and the aging of the rubber body is extremely slow and requires longer than the total life of the car to make any appreciable change.

In General

Lightweight Plastics

DEVELOPMENT of a new foamed plastic, so light that four cubic feet can be balanced on the fingertips of one hand, and yet so strong that luggage made with it as a core will easily support a man's weight, was announced by the du Pont Company, Wilmington, Del.

Called cellular cellulose acetate, the new plastic is envisioned for use as the strong lightweight cores in airplane floor-panels, tail assemblies, and wing structures, and in refrigerators, luggage, and sections of prefabricated houses.

Lighter than cork, this new plastic combines insulation against heat and cold with its remarkable structural strength when bonded between two sheets of metal, wood, or plastic.

Repeating Flash Bulb

A repeating flash bulb, for use with a special electroflash unit that can be used for several thousand individual flashes of brilliant daylight-quality photographic illumination has been announced by Wabash Photolamp Corporation, Brooklyn, N. Y.

The new flash bulb provides a light output of 12,000,000 peak lumens in an instantaneous flash, the equivalent of $^1/_{5000}$ sec. Preliminary color tests indicate that the color quality of the light is already corrected to approximate that of normal daylight so that no filters will be required for indoor use with daylight-type color films.

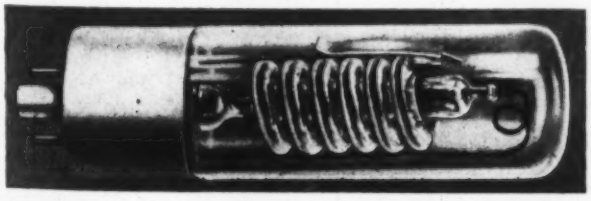

FIG. 14 REPEATING FLASH BULB

Inside the bulb is a Xenon gas-filled coiled glass tubing running between two electrodes. Condensers discharged through this coil provide the illumination.

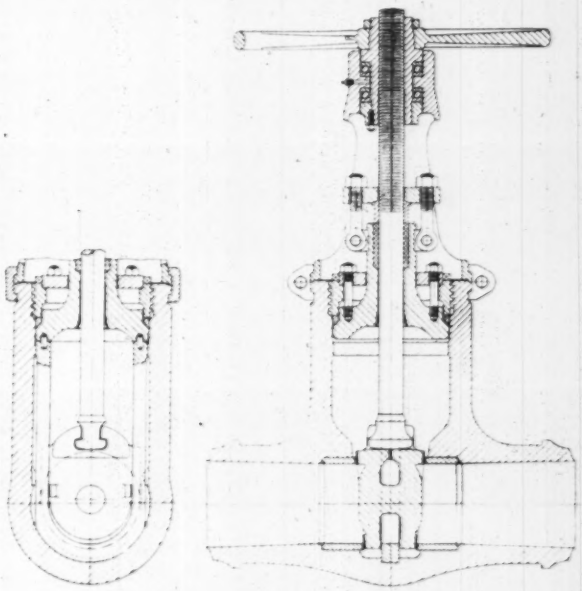

FIG. 15 SECTIONAL VIEW OF AN 8-IN. 1500-LB GATE VALVE

New Pressure-Seal Valves

Crane Company, Chicago, Ill., announces a new line of valves, designed for high-pressure, high-temperature steam service, primarily in the 1500-lb and 900-lb pressure classes, with welding ends and embracing gate, globe and angle, and automatic stop check valves.

The design incorporates important changes and some departures from previous conventional types of construction.

Chemicals for Industry

Publication of an illustrated 212-page book entitled "Chemicals for Industry," has been announced by the Rohm and Haas Company. Portions of the book give brief histories of the Rohm and Haas Company and its associate firms, The Resinous Products and Chemical Company, and Charles Lennig and Company, Inc. In addition, the development, manufacture, and many uses of various products such as plastics, insectides and fungicides, coating resins, and chemicals for the leather, textile, rubber, enamelware, and other industries, are described in various chapters of the book.

Thickness-Measuring Gage

A new type of instrument gage for measuring the thickness of metal sheet stock has been developed by The Glenn L. Martin Company, Baltimore, Md. The device may also be used for inspecting the bonds between the laminar layers of laminated materials.

Operating on the pressure principle, the gage consists of an inverted cup-shaped shell with a top wall of transparent material and the bottom rim edged with a rubber gasket. Mounted inside the shell is a $^1/_{1000}$-in. dial indicator equipped with a stem reaching to a spherically shaped foot, which, when the instrument is being used, rests against the metal sheet surface.

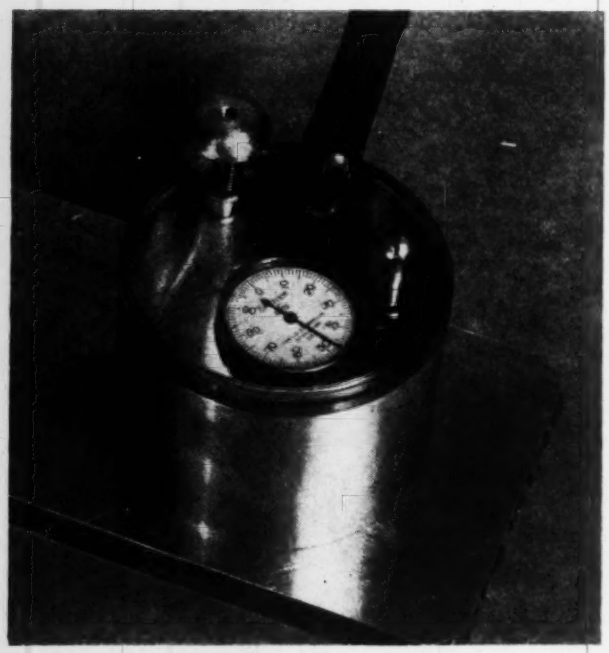

FIG. 16 THICKNESS-MEASURING GAGE

A valve in the top of the case is connected to an exterior pump so that air inside the gage can be withdrawn or the pressure reduced to any desired or predetermined amount.

When in use the gage is placed on the area to be inspected, the valve opened, and the air inside the instrument allowed to reach normal atmospheric pressure. A reading is then taken which acts as a standard for the test. With the valve again closed, the air is evacuated and, should there be a faulty bond or no bond between the surface sheet and the adjacent layers, this "loose" sheet area will pull away from the other layers against the foot of the gage and a deflection of several thousandths of an inch will be detected on the dial.

In measuring the thickness of sheet metal, the pressures recorded during the test are checked against predetermined gage readings for each thickness of the metal.

Ferritic Steels Report

Availability of a report on "Behavior of Ferritic Steels at Low Temperatures," prepared by Dr. H. W. Gillett, Battelle Memorial Institute, and Francis T. McGuire, University of Kentucky, has been announced by the American Society for Testing Materials. The report, issued in two parts, covers the extensive data resulting from experimental work carried out at the University of Kentucky as a War Metallurgy Committee project. However, many data that were obtained from other sources have been included in this report. The publication therefore is a general one, rather than restricted solely to the experimental project.

Authorized for A.S.T.M. publication by the War Production Board's Office of Production Research and Development, the report is considered most important, in that Part I contains an extensive discussion of the project, the materials included, and the data resulting from the intensive experiments. Part II contains some 250 figures, diagrams, and photomicrographs.

The work was intended to secure a comprehensive set of experimental data on the low-temperature behavior of commercial National Emergency, S.A.E., and similar steels. It was felt some of the points would clarify the relation of composition, heat-treatment, grain size, etc., to low-temperature behavior.

New Supersonic Wind Tunnel

The National Advisory Committee for Aeronautics recently announced a new supersonic wind tunnel, the largest in the United States, for research in the problems of high-speed flight.

The 1500-mph wind tunnel, located at the Ames Aeronautical Laboratory of the N.A.C.A. at Moffett Field, Calif., is designed to operate exclusively above the present limit of human flight imposed by the same phenomenon, the velocity of sound (approximately 760 mph). In the range of speeds above this natural barrier, until recently penetrated only by pilotless projectiles, tests will be conducted upon models of guided missiles and jet- and rocket-propelled aircraft. From this fundamental research will be obtained a knowledge of the design requirements for stable and controllable flight at the tremendous speeds made possible by recently perfected systems of propulsion.

Accurately made steel models are mounted in the three-square-foot test section of the tunnel. Air is forced through this constricted channel at twice the speed of sound, simulating conditions encountered by a supersonic aircraft.

(An article in the December, 1945, issue of MECHANICAL ENGINEERING, pages 827–833, 835, describes the features of the Ordnance Supersonic Wind Tunnel, Aberdeen, Md.)

Height Gage

A new 48-in. Chesterman height gage for precision inspection, layout, scribing, and checking large-size jigs, fixtures, dies, and castings is being presented by George Scherr Company, New York, N. Y.

The gage employs an extra large vernier measuring 2.450 in. in length, thus the verniers which read to $^1/_{1000}$ in. on the English scale and $^1/_{50}$ mm on the metric scale, may be quickly read without the necessity of removing the gage from the work and holding it up to the eye employing magnifiers.

The fine adjustment located in the base as illustrated in Fig. 17 is an outstanding feature, since, in making adjustments, the downward pressure on the screw instead of causing tilting and moving of the height gage, as may occur in ordinary gages, helps in holding the tool more firmly to a surface plate.

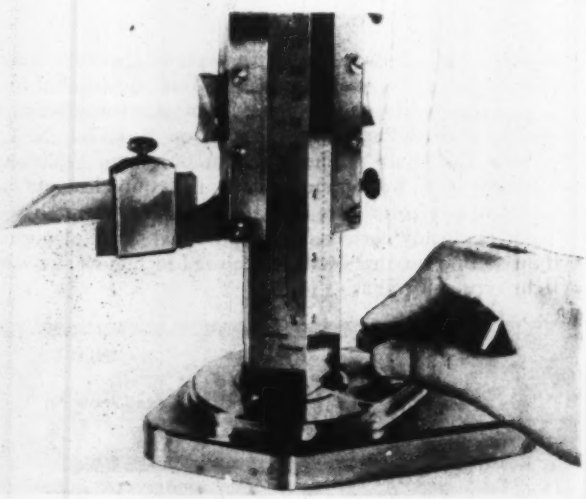

FIG. 17 NEW HEIGHT GAGE

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

An American Society of Engineers

To the Editor:

Mr. Virgil M. Faires' article in the November, 1945, issue of Mechanical Engineering proposing an American Society of Engineers has caused considerable discussion which may well prove beneficial to all graduate engineers. If it had not been for "advantage number 7" plus the final paragraph of the article, little comment could be made. The combination of these two paragraphs touches the engineers in a tender spot and brings out questions not often discussed.

"Advantage number 7" reads: "The A.S.E. would undertake certain public-relations functions (such as collective-bargaining arguments, union proposals, relations with W.L.B., etc.) so that the associated societies could devote their entire efforts to the exchange of professional-engineering ideas and to the advancement of engineering knowledge."

Before discussing this paragraph we must first clarify the make-up of the organization. I assume that the membership would include engineers who are employees as well as engineers who are employers, following a pattern similar to that used by the A.S.M.E. and other similar technical organizations. If this is so, then collective-bargaining *arguments* could be presented, but collective-bargaining *agreements* would not be possible, because agreements are made between defined groups as employees and employers (labor and management). Further, the mention of collective bargaining indicates there must be economic or wage questions involved; yet we are so far discussing professional people who are not unionized. Another question then arises as to what extent the A.S.E. would deal with union proposals or have dealings with any governmental wage-control panel such as the former W.L.B. The difficulty again is that the A.S.E. would represent both employees and employers with the added complication that the members would be employees of numerous industrial organizations. A solution for this is suggested later.

In his final paragraph, Mr. Faires states that welders and truck drivers can make more money than graduate engineers. If this is true it is only true because welders and truck drivers have had their jobs evaluated, then set into a union pay scale which was agreed to by the employers through collective bargaining and possibly approved by the W.L.B. The welders and truck drivers convinced someone that their work was worth the wages requested.

I know of a case where civil engineers organized themselves in a certain area and agreed at their meeting that they would not work for less than a certain wage. Their various employers, however, did not agree with the wages set and paid the rate set by the company which was less, of course, than the rate requested by the organization.

There are already unions of groups which include professional people with the others. It may be an abhorrent thing for professional engineers to have to organize but the scientific and technical work performed by engineers resulting in many invaluable accomplishments for the use and comfort of mankind should warrant greater rewards to the engineers. Doctors, lawyers, dentists, and other professional people are usually in business for themselves. They stand out in the community as professionals and are compensated accordingly. A very small percentage of engineers are self-employed. Perhaps the fact that most engineers work in large organizations causes the professional aspect of their work to be lost.

In conclusion, if my foregoing interpretations of the article have been correct and if graduate engineers are to attempt to handle union proposals and collective-bargaining questions the solution would be to form associations in their own companies, these associations representing employees who are not part of management. The various individual associations would have to be represented by a parent organization such as the A.S.E. Then "advantage number 7" can be made to work and on a high plane of ethics. The National Council Engineers, Draftsmen, and Associates is interested in this problem and has been solving similar problems for several years. The engineers should review their situation and recheck Mr. Faires' article to see if he has not brought up some problems which have solutions.

Charles C. Gray.[1]

Gas Turbine in Aviation

Comment by L. T. Ting[2]

Regarding the authors' statement on the improvement in engine output with increasing back pressure,[3] the pumping-stroke power would not increase with an increase in back pressure as much as indicated in Fig. 7. Hale and Olmstead[4] found that even with an intake-manifold pressure of 8 in. Hg above atmospheric and an exhaust back pressure of 16 in. Hg below atmospheric, the C.F.R. engine pumping-stroke power was still negative. Thus there will not be a positive pumping-stroke power even with the back pressure appreciably lower than the intake pressure. Also, the reference given indicates that the rate of increase of pumping-stroke power from low back pressure to high back pressure will be less than that shown in Fig. 7.

The specific power, as shown in Fig. 7, gives no indication of the variation of the real engine power with back pressure, for the volumetric efficiency of the engine will decrease rapidly with an increase of back pressure.[5] If more air were introduced to compensate for the power loss, boosting to the detonation limit, then the supercharger power must be increased as the back pressure increases. The supercharger power, as shown in Fig. 7, shows no appreciable variation throughout the whole range of back pressures.

The authors apparently have drawn their conclusions, based upon the analysis of an ideal engine cycle. Therefore it is doubtful whether their statement should be applied to actual practice. If

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[2] Southwestern Associates University, Kunming, China. Present address, Yale University, New Haven, Conn.

[3] "The Gas Turbine in Aviation—Its Past and Future," by S. R. Puffer and J. S. Alford, Mechanical Engineering, vol. 67, 1945, pp. 803–812.

[4] "The Internal Combustion Engine," by C. F. Taylor and E. S. Taylor, International Textbook Company, Scranton, Pa., 1938, p. 191.

[5] Ibid., p. 235.

not, the improvement in engine output with increasing back pressure is not clearly indicated in Fig. 7. Thus, it appears that a maximum net compound engine power will occur at an engine back pressure much less than 50 in. Hg abs for the case illustrated.

ANSWERING COMMENT

Fig. 7 in the authors' paper was based upon actual test data of typical aircraft engines. The engine performance used probably deviates from the performance of the C.F.R. engine because of the large differences in relative valve area, valve timing, and manifolding. The specific power (the inverse of the specific fuel consumption) is more significant in Fig. 7 than would be the actual value of engine power as the conditions considered were those of cruising operation, where the actual power level is of little importance as it can be readily adjusted up or down by varying the engine speed or manifold pressure, while every effort is necessary to obtain the maximum power per pound of gasoline expended.

L. J. FISHER.[6]

[6] Aircraft Gas Turbine Engineering Division, General Electric Co., West Lynn, Mass. Jun. A.S.M.E.

Glued-Laminated Arches

COMMENT BY A. G. H. DIETZ[7]

This paper[8] demonstrates again that good glue joints can be made with smoothly sawed wood surfaces if the gluing technique itself is good, but that improper handling of one factor, such as failing to provide uniform clamping pressure, or permitting rough and torn areas to exist in the glue line, results in poor bonds.

It is recognized, of course, that a smoothly planed surface, all other things being equal, results in a stronger glue line than does a sawed surface, even when smoothly and uniformly cut. The question can properly be raised, however, when must the optimum gluing condition exist in the member, i.e., when must the maximum shear strength be developed? Evidently, optimum shear strength is needed only when shear is the controlling element in the design. Generally speaking, this occurs when bending moments are changing rapidly, as is likely to be the case in short deep beams carrying heavy loads.

The three long and two short test specimens cited by the author, with span-depth ratios of 12.5 and 13.7, respectively, begin to approach the critical ratios at which shear is likely to control, and two of the test beams in which glue lines are especially faulty (one damp), do fail in shear. The other beams, with relatively good glue lines (smoothly sawed surfaces, but rather poor clamping procedure) fail in the outermost laminations. The rate of change of bending moment is moderately severe in all cases.

Considering the results of the few tests made by the author, together with the more extensive tests of the Forest Products Laboratory and the New York State College of Forestry, it would appear logical to employ carefully and smoothly sawed laminations for glued members in which the shear stresses are not severe enough to be the controlling factor in design, reserving the superior but more expensive and wasteful planed surfaces for members in which the utmost in shear strength must be developed.

One other factor, little recognized and only slightly explored, may call for further attention in the decision to employ sawed or planed surfaces. Another current paper[9] shows that tensile stresses, as well as shear stresses, may be set up in the glue lines of laminated timbers as they undergo changes in moisture content. Relatively little has been done in the evaluation of the tensile strengths of glue bonds; consequently, it is difficult to say whether a sawed or a planed surface would be superior in this respect. The importance of tensile strength is beginning to be recognized by such organizations as the Adhesives Committee of A.S.T.M., but a considerable amount of work is necessary to evaluate this property.

COMMENT BY FRANK J. HANRAHAN[10]

The findings reported in this paper are of particular interest because they pertain to commercially made glued-laminated lumber under conditions of actual service. Although laboratory tests are needed and of great importance in determining effect of factors under controlled conditions, it is difficult to simulate closely in a laboratory the actual conditions of service. After all, the final criterion of a product is the service it gives.

Recently, there has been considerable investigation of the effect of character of the wood surface to be glued on the integrity of the glue line. The question of whether sanding of surfaces to be glued was necessary or desirable has been under discussion. In this case the concensus of opinion supported by technical data seems to be that it is desirable to sand veneer to be glued into plywood but not lumber to be glued into laminated lumber. In the case of lumber the objection is not so much to the sanding per se but to the impracticability of getting a flat surface contour in the sanding operation. The edges of the piece are likely to be rounded somewhat and the thickness of a piece somewhat variable after commercial sanding operations and consequently a true flat surface is not provided for intimate surface contact.

Also, it appears that vacuum cleaning or even brushing of sanded surfaces is not of any particular value in improving the surface for gluing. This of course assumes that the loose sawdust and sanding dust is dropped off during handling and that the material has not become dirty from sources other than normal woodworking operations.

The author's findings go a step further in suggesting the use of well-sawed surfaces instead of machined surfaces. As he states, one of the keys to a good glue joint is that the surfaces be such that there be intimate contact of the wood surfaces to be glued together. The general flatness (flat contour of surface and uniformity of thickness of lamination) appears to be a more important factor in providing a good glue joint, than minor variations in the texture of the finished worked surfaces.

COMMENT BY T. R. C. WILSON[11]

The author has drawn data from various parts of U. S. Department of Agriculture technical bulletins[12] and other sources and has used them for comparisons for which they are not well adapted. Furthermore, some unusual procedures have been used. For example, load-deflection curves, Figs. 7(*a*) and 7(*b*), for beams of coast Douglas fir of average quality have been constructed by adjustment for moisture content and for size of specimen on the basis of data from U. S. Department

[7] Assistant Professor of Structural Engineering and Materials, Department of Building Engineering and Construction, Massachusetts Institute of Technology, Cambridge, Mass.

[8] "Glued-Laminated Arches With Sawed Laminations," by E. A. Dubin, MECHANICAL ENGINEERING, vol. 67, 1945, pp. 813–819 and 838.

[9] "Glue-Line Stresses in Laminated Wood," by A. G. H. Dietz, Henry Grinsfelder, and Eric Reissner, Trans. A.S.M.E., vol. 68, no. 4, 1946, pp. 329–335.

[10] National Lumber Manufacturers Association, Washington, D. C. Mem. A.S.M.E.

[11] Chief, Division of Timber Mechanics, United States Department of Agriculture, Forest Service, Forest Products Laboratory, Madison, Wis.

[12] Refer to author's Bibliography (1), (3).

of Agriculture, Technical Bulletin No. 479[13] and elsewhere.

Loads developed in the tests of laminated beams performed by the author having been found in error because of an inaccurate dynamometer, estimated loads and stresses were found from the deflections measured in test, and the assumption made that for each of these beams the true load-deflection graph was identical with Figs. 7(*a*) and 7(*b*). The validity of this procedure is subject to question. The variability of wood is such that reliable information on such comparisons as that between the gluing of sawed surfaces and the gluing of planed surfaces can be acquired only from tests in which close matching of material between the two types of joint is practiced.

The author's final conclusion seems to be based principally upon data presented in his Fig. 8 and taken from item (7) of the Bibliography. These tests were made on laboratory-prepared specimens, the sawing of which may have been more carefully done than would be accomplished in the preparation of large quantities of lumber on a production basis. At one point in the article a poor joint is attributed to variation in the thickness of laminations, although the earlier statement was that the resawed material was of uniform thickness.

The gluing of sawed surfaces in the formation of glued-laminated structural members is a moot point on which fully conclusive evidence is not available. Joints between sawed surfaces can be readily glued to show 100 per cent wood failure when separation by splitting or shear is forced. There is strong suspicion, however, from some investigations and observations that a thin layer of fibers adjacent to the surface may be severely damaged by the sawing and in such an instance 100 per cent wood failure does not prove that the inherent strength of the wood has been attained by the glued joint.

Of more importance perhaps than the smoothness of surface is the uniformity of thickness. Uniformity is essential to the good contact and the continuity of a glued joint, which is necessary to adequate glued joints.

It is true that in many instances the shear stress in glued-laminated members, arches in particular, is low enough so that considerably less than 100 per cent shear strength is needed and could be tolerated. However, it is doubtful that there is any way to ease fabrication requirements so that values just adequate to the requirements of service will be attained without incurring the danger that nontolerable deficiency in shear resistance will result because of stress concentrations caused by insufficiently glued areas. Hence it seems wise to insist on planed surfaces. At least a greater uniformity of thickness is necessary than can be expected from sawing or resawing as it is done in many woodworking plants. The British have permitted the use of sawed laminations in laminated airplane members. They have, however, required very careful sawing and very careful inspection and measurement to assure uniformity of thickness.

The conclusions drawn in this paper are probably more general than is justified by the evidence given:

1 The results, obtained from laminated arches built at New London and from the tests on experimental beams preceding the fabrication of the arches, are based on including one planed face with one sawed face in each glue joint. This should be recognized as a more favorable gluing condition than the combining of two sawed surfaces contemplated in the conclusions given.

2 In addition to the strength and durability required of glue joints in laminated wood, the effect of conditions of exposure in service must also be considered. In order to draw general conclusions on the adequacy of the glue joints observed, it would be necessary to show that the exposure conditions in service, such as paint or other protection on the surface of the laminated arches, and the atmospheric conditions and range in service were typical and sufficiently extensive in this installation to warrant the general conclusion.

[Mr. Dubin's closure to the foregoing discussion will appear in a later issue.—EDITOR.]

[13] Refer to author's Bibliography (3).

Correction

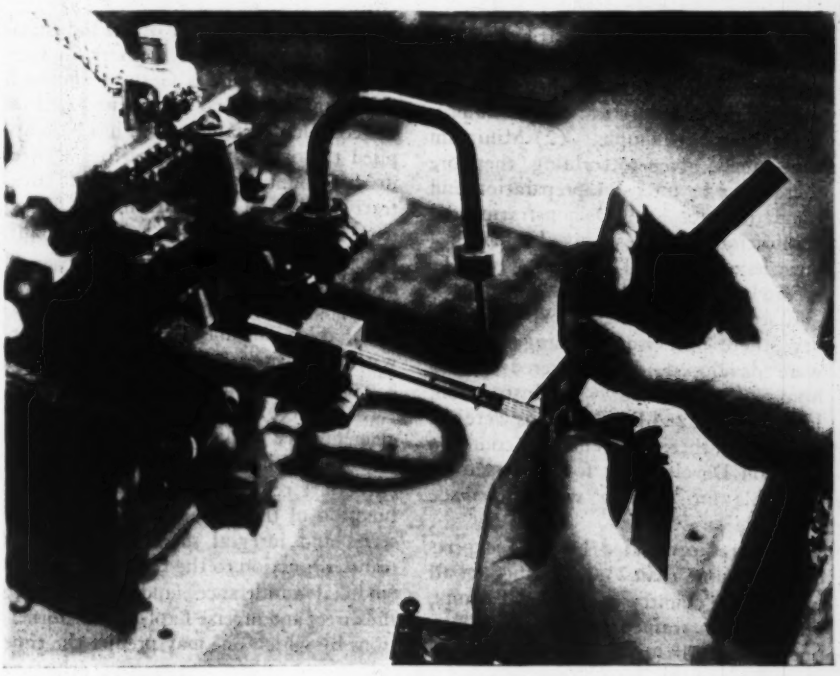
TO THE EDITOR:

In my paper entitled "Stresses in a Reinforced Monocoque Cylinder Under Concentrated Symmetric Transverse Loads" published in the December, 1944, issue of the *Journal of Applied Mechanics* there is an error in sign in Equation [5]. I shall be glad to furnish any one with a mimeographed errata sheet containing the changes in the final equations for the bending moments resulting from the correction of this error.

The equations originally given in the paper are valid in the special case when the external load is a single concentrated radial force applied at the lowest point of the ring ($\alpha = 180$ deg). Consequently the numerical calculations, diagrams, and their discussion are correct as printed.

N. J. HOFF.[11]

[11] Associate Professor of Aeronautical Engineering, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. Mem. A.S.M.E.



OPERATOR SPOT WELDS TANTALUM GRID WIRES (0.0007" DIAM) TO TANTALUM SLEEVE FOR A VT90 TRANSMITTING TUBE AT THE BROOKLYN, N. Y., PLANT OF AMPEREX ELECTRONIC CORPORATION

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

The Training Within Industry Report, 1940–1945

THE TRAINING WITHIN INDUSTRY REPORT, 1940–1945. U. S. Government Printing Office, 1945. Paper, 6 × 9 in., 330 pp., $0.50.

REVIEWED BY A. C. HARPER[1]

THIS is the final official report of the activities of the Training Within Industry Service of the War Manpower Commission which functioned during World War II. Issued as a narrative account of its service to more than 16,000 war plants, it shows in a highly instructive manner the development and operation of the organization and its programs, how management had to be sold on the use of its programs, what mistakes were made, improvements evolved, and results obtained.

The heads of TWI found that supervisors were the key to the problem of quickly getting skilled work from the hundreds of thousands of inexperienced new workers. Supervisors needed to know their work and their responsibilities, to possess skills in instructing, improving methods, and leading. TWI resolved on four requirements for training in defense industries: (1) The program must be simple. (2) Minimum time can be given to training, therefore there must be intensive preparation and standardization. (3) Demonstration and application, or "learning by doing," must be used. (4) The training must be spread by using "multipliers."

Based on the findings of extensive surveys, three supervisory training programs were developed, each covered in ten hours of instruction. Job Instruction, Job Methods, and Job Relations were the titles given these programs. A course in Program Development for staff men responsible for training was also made available.

Institutes conducted by TWI experts qualified more than 23,000 trainers in all parts of the country in industrial plants, who in turn trained supervisors. Over one and a half million supervisors had been certified in Job Instruction alone, and lesser numbers in the other programs by October, 1945. With these newly learned techniques supervisors instructed uncounted millions of inexperienced workers in a variety of plants in the United States and a dozen allied foreign countries.

Management contributed immensely to the success of TWI by lending to it for the duration of its activity the services of many of its highly-trained personnel.

TWI programs have accomplished several important results. They have opened the eyes of management to the important contributions that men and women in supervisory positions could make toward quantity and quality output, and to the need for in-plant training to develop the knowledge and skill of all their workers.

The TWI Report will interest those individuals in both management and organized labor who are competent to carry on training in Job Instruction, Job Methods, and Labor Relations, thereby meeting the needs of workers, management, and industry.

[1] President, The Wyomissing Polytechnic Institute, Wyomissing, Pa. Mem. A.S.M.E.

Dynamics of Automatic Control

DYNAMIK SELBSTTÄTIGER REGELUNGEN. By R. C. Oldenbourg and Hans Sartorius. Oldenbourg Press, Munich, Germany, 1944, 283 pp., 112 figs., 33 references, 13 m.

REVIEWED BY H. L. MASON[2]

THIS little book on the dynamics of automatic control is part of report No. 523 of the Field Intelligence Objectives Agency, "A Study of the Industrial Processing Instrument Industry in Germany." It presents a German approach to the mathematical treatment based on the complex variable which has been applied to some extent by various writers in this country and in England. Illustrative physical applications are drawn from liquid, gas, electrical, and mechanical "fluid" circuits.

The control loop is described as consisting of the controller (measuring device, pilot member, and servomotor, with or without followup) operating on a plant (manipulating member and disturbed space). The inputs to its various elements are assumed to take the form $Ze^{i\omega t}$ and their responses or output effects are related thereto by a complex function of the frequency. The Fourier series and integral serve to relate this transfer function to the response function (indicial admittance) and to introduce the direct and inverse Laplace transformations by which one may predict the time behavior resulting from any arbitrary disturbance. A discussion of the stability criteria of Hurwitz and Nyquist is followed by a development of the transfer function for unidirectional elements in series and in parallel, and by its application to the closed feedback loop. Optimal control is defined as an aperiodic response having a minimum area referred to the sustained deviation.

Elements with and without eventual static correspondence are described and defined, then stabilizing devices for the latter: rigid and restorative followups, and derivative-action devices. Various combinations of these linear elements in continuously operating control are next discussed, including the cases of resistance and capacitance lumped and distributed, dead-time, inertia effect, adjustable floating action, and n-membered plants with their approximations. Plots in nondimensional variables and appropriate characteristic times permit one to make numerical comparisons of these combinations in respect to their responses and to the conditions for continuous oscillation, decaying oscillation, aperiodic behavior, and optimal control. Free use is made of graphical solutions, series developments, and base-wave behavior. These plots, of general validity for any dynamical circuit, are perhaps the most useful feature of the book.

Discontinuities arising from backlash, friction, and differential gap are next discussed, with an example of their analytical handling. This leads to the

[2] Research Professor of Mechanical Engineering, Iowa State College, Ames, Iowa. Mem. A.S.M.E.

analytical treatment by finite difference equations of on-off controllers and intermittently acting deviation-responsive controllers. Again, nondimensional plots provide numerical data concerning response behavior, limits of continuous oscillation and aperiodicity, and optimal control, for several forms of step-wise control action on typical plants. Finally, intermittent action is compared with continuous action, on a plant with dead-time, and the former is shown to give a smaller deviation area at the aperiodic limit.

An appendix lists formulas for the Laplace transformation, for difference equations, and for typical elements and combinations of the dynamical circuit. A bibliography includes several German references of 1940 and 1941.

Secrets of Industry

SECRETS OF INDUSTRY. By Lewis C. Ord. Emerson Books, Inc., New York, N. Y. Cloth, 5 × 7⅜ in., 255 pp., $3.

REVIEWED BY J. M. JURAN[3]

MR. ORD, a British engineer, writes on a familiar theme: If British industrialists would but adopt American technological methods, British productivity could rise from its present unsatisfactory level. However, Mr. Ord does not add to what has already been said. Moreover, his own saying of the same thing is too inadequate to constitute a contribution through superior restatement.

Mr. Ord's comments concerning conditions in the United States are evidently based on other than first-hand information. In places he is positively naïve. He praises the way that Detroit works without racial conflict. He flatly states that there were on the War Production Board "no minister or politician" and "no heads of great companies or men representing huge financial interests."

His concept of American Industry as a frictionless machine is equally naïve, though not subject to similar instances of out and out contradiction. The fact that accurate statements are commingled with Mr. Ord's surmises is not enough to convert his conclusions into expert opinion.

The discussion concerning British Industry is far from being analytical. Mr. Ord considers that the British can compete with American shipyards, but not with American steel mills. He therefore belabors the British steel industry for protecting inefficient producers. Yet he offers no explanation for the "success" of British shipyards, whether through better methods, or inferior competition, or what.

The title "Secrets of Industry" runs through the book like a will-o'-the-wisp. But little of what Mr. Ord "discloses" is secret. Rather, it is well known. Here is just another situation in which we would all be better off if we could just apply what we already know.

Those who would read an incisive discussion of British vs. American productivity should see the series of articles entitled "A Policy for Wealth" published in the London *Economist* in the Spring of 1945.

[3] Professor and Chairman, Department of Administrative Engineering, New York University New York, N. Y. Mem. A.S.M.E.

Books Received in Library

CURSO DE HIDRAULICA. By F. J. Dominguez. Second edition, enlarged. La Universidad de Chile, Santiago de Chile, 1945. Leather, 7½ × 11 in., 651 pp., diagrams, charts, tables. This work, by a professor of theoretical hydraulics at the University of Chile is intended to provide a text for students of engineering and for practicing engineers. It offers a well-balanced course in which special attention has been paid to recent work in the United States, in Chile, and in Argentina. The present edition has been thoroughly revised and enlarged and is provided with numerous useful tables and charts and bibliographic footnotes.

DAMPFKESSELSCHÄDEN, ihre Ursachen, Verhütung und Nutzung für die Weiterentwicklung. By E. Pfleiderer. Julius Springer, Berlin, Germany; J. W. Edwards, Ann Arbor, Mich., 1934. Cloth, 5½ × 8¾ in., 259 pp., illus., diagrams, charts, tables, $7.85. This book, originally published in 1934, is a systematic review of the sources of boiler failures, particularly those resulting from modern demands of high temperature and heavy loading. The points to be guarded in casting and cooling boiler steel and in its heat-treatment are first discussed. Then follow chapters on boiler design, on construction, and finally, on operation and possible sources of damage.

DEMOCRATIC ADMINISTRATION. By O. Tead. Association Press, New York, N. Y., 1945. Cloth, 6 × 9¼ in., 78 pp., $1.25. In this small volume, Part 1, entitled "Creative Management," considers the nature and aims of organizations for social, civic, and character-building purposes in order to establish effective administrative procedures. Part 2, "Democracy in Administration," develops in a more general way the thesis that "the process of determining purpose, policy, and method is advisedly seen as shared, and the process of oversight and direction is seen as unified and single."

MACHINE-TOOL WORK, Fundamental Principles. By W. P. Turner and H. F. Owen. Second edition. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1945. Cloth, 5 × 8½ in., 364 pp., illus., diagrams, charts, tables, $3. This textbook, based upon a course in the subject given at Purdue University, offers systematic instruction in the fundamental principles of the subject that will serve as a background for the necessary further study of industrial processes and practices.

NORMALISATION. By J. Maily, preface by P. Salmon. Dunod, Paris, France, 1946. Paper, 6½ × 9¾ in., 472 pp., 375 fr. In this interesting study of standardization, attention is given especially to the legal aspects of the subject and on its effects on the general economy of a country. The principles and methods of standardization and the applications of standards are reviewed in the first section. The second deals with standardization in France. Standardization in Germany and England is briefly reviewed, as is international standardization.

RAILROAD AVENUE, Great Stories and Legends of American Railroading. By F. H. Hubbard. McGraw-Hill Book Co., Inc., Whittlesey House Division, New York, N. Y., and London, England, 1945. Cloth, 6 × 9 in., 374 pp., illus., maps, $3.75. The author of this new book on railroading and railroaders has collected his material with an eye for entertaining. Among the stories and legends are authoritative versions of old favorites, as well as a variety of lesser-known and obscure items from the full history of the period. Songs and poems from and about railroad life are reproduced, and there is a vocabulary of "railroad lingo." The book is well-illustrated by contemporary portraits, drawings and photographs.

RUSSIAN-ENGLISH SCIENTIFIC-TECHNICAL DICTIONARY, compiled and edited by A. Bray. International Universities Press, New York, N. Y., 1945. Cloth, 6 × 9½ in., 551 pp., $10. The scope of this dictionary is indicated by the types of words included: Basic terminology of fundamental fields such as mathematics, mechanics, physics and chemistry; words and expressions for all the main technical fields likely not to be found in a general dictionary; terms pertaining to new fields of science and industry, to new equipment and processes; newly-coined Russian technical words and phrases, and old Russian terms which have acquired new meanings as technical idioms.

TREATISE ON APPLIED HYDRAULICS. By H. Addison. Third edition, revised and enlarged. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, London, England, 1945. Cloth, 5¼ × 8½ in., 614 pp., illus., diagrams, charts, tables, $6.50. The purpose of this book is to present a compact summary of the fundamental principles of hydraulics and of the manner in which they are applied by the engineer. Particular attention has been given to the following topics: Frictional loss in closed and open conduits; pressure and thrust on immersed solids; water hammer in pipes; and pressure distribution on pump and turbine blades. There is a bibliography divided by chapters.

URANIUM AND ATOMIC POWER. By J. De Ment and H. C. Dake. Chemical Publishing Co., Brooklyn, N. Y., 1945. Cloth, 5½ × 9 in., 343 pp., illus., diagrams, charts, tables, $4. Following a brief discussion of the background and possibilities of atomic power, come chapters on the constitution of uranium minerals and prospecting methods. Chapters 4 and 5 deal respectively with the physics and chemistry of uranium. Chapters 6 and 7 cover in detail the methods used in the detection and determination of uranium. A large bibliography of original sources of information and a number of tables of useful data are appended.

A.S.M.E. NEWS

And Notes on Other Engineering Socteties

Tentative Program of the 1946 Semi-Annual Meeting to Be Held in Detroit Mich., June 17 to 20, 1946

THE 1946 Semi-Annual Meeting of The American Society of Mechanical Engineers, to be held at Hotel Statler, Detroit, Mich., June 17 to 20, 1946, will be the largest of four national meetings sponsored by the Society during this the first peacetime summer since 1939.

Detroit, Mich., the heart of the world's automotive industry, will be the main point of interest on what may be compared to an A.S.M.E. transcontinental tour of industrial America. In Buffalo, N. Y., Milwaukee, Wis., and Los Angeles, Calif., other national meetings sponsored, respectively, by the Applied Mechanics, Oil and Gas Power, and Aviation Divisions, all to be held within the twenty-day period between June 2 and 22, 1946, will call attention to the nation-wide activities of the A.S.M.E.

The Semi-Annual Meeting will be the cooperative effort of many professional divisions. Technical papers, many of which will be locally inspired, social gatherings of prominent engineers and industrialists, and inspection trips to local industrial plants, will dramatize the engineering contributions of Detroit, Mich., the fourth largest of the nation's industrial centers—engineering contributions which helped to make America the "arsenal of democracy."

Technical Sessions

During the eight groups of technical sessions that have been scheduled 74 papers will be presented by the following divisions: Fuels, Heat Transfer, Industrial Instruments and Regulators, Machine Design, Metal Cutting, Metals Engineering, Oil and Gas Power, Power, Process Industries, Production Engineering, Rubber and Plastics, Aviation, and Management. There will be other sessions on the following subjects: Great Lakes Carriers, Training for the Industries, and Automotive Engineering.

Luncheons

Four general luncheons are planned. At the luncheon on Monday, June 17, James W. Parker, past-president, A.S.M.E., and president, Detroit Edison Company, Detroit, Mich., will speak on the general outline and scope of the 1946 Semi-Annual Meeting. At the luncheon on Tuesday, June 18, J. Parker Van Zandt, The Brookings Institution, Washington, D.C., will discuss "Air Transportation and World Understanding." The speaker at the luncheon on Wednesday, June 19, will be Lieut. Col. Edward H. Gray, Aberdeen Proving Grounds, Aberdeen, Md., who will discuss development of tanks and military vehicles.

A.S.M.E. National Nominations

THE 1946 Nominating Committee invites Members to appear at its open meeting June 17, 1946, at the Statler Hotel, Detroit, Mich. Members may present their views concerning candidates for the offices of President, Regional Vice-President, or Director-at-Large, any time between the hours of 1 p.m. and 5 p.m. on Monday, June 17, 1946.

Nuclear Energy

Nuclear-energy applications will be the subject of a discussion at the dinner meeting planned for Monday evening. D. Robert Yarnall, president, A.S.M.E., will serve as chairman of a program which will consist of two talks by members of the A.S.M.E. Committee on Nuclear-Energy Applications on the scope and the opportunities facing the Committee. During this program Senator Brien McMahon, Washington, D. C., will discuss

SKY-LINE VIEW OF DETROIT, MICH., FROM THE DETROIT RIVER

legislative control of nuclear-energy applications.

Inspection trips

For members and guests who wish to become familiar with the industrial environment of Detroit, Mich., inspection trips have been arranged for each afternoon of the meeting. On Monday there will be a trip to Canada where a visit will be made to the Hiram Walker Distilleries. On Tuesday afternoon an inspection party will leave to board a lake ore carrier that will be delayed in Detroit to be available during the A.S.M.E. Semi-Annual Meeting. On following days the Ford Motor Company plant at River Rouge, Mich., the Plymouth Motor Car plant, the Ex-Cell-O Corporation plant, and the U. S. Rubber plant will play hosts to parties of A.S.M.E. members and guests.

Women's Program

The Woman's Auxiliary of the A.S.M.E. under the chairmanship of Mrs. P. W. Thompson has arranged an interesting program. Monday afternoon has been given over to a tour of Rackham Memorial Park. This will be followed by tea at the Engineering Society of Detroit. An informal bridge party has been planned for the evening. On Tuesday a morning trip to Willow Run plant is on the program. Following a lunch at Dearborn Inn, the party will visit Greenfield Village, Dearborn, Mich. On Wednesday morning a party will drive around the lake shore and stop for luncheon and bridge at the Detroit Yacht Club. On Thursday the Woman's Auxiliary will visit Canada.

Committee

Members of the general committee of the A.S.M.E. Detroit Section who worked hard to plan and organize the 1946 Semi-Annual Meeting are: J. W. Armour, chairman; R. K. Weldy, Tom Jeffords, and C. J. Freund, vice-chairmen; H. S. Walker, chairman, finance committee; A. Wm. Honywill, chairman, technical events committee; J. H. Spurgeon, chairman, printing and signs committee, R. V. Eley, chairman, hotel committee; T. E. Winkler, chairman, entertainment committee; R. H. Stellwagen, chairman, committee on plant trips; H. K. Gandelot, chairman, committee on information and registration; J. F. Jarnagin, chairman, publicity committee; O. A. Soderberg, chairman, reception committee; A. C. Pasini, chairman, A.S.M.E., Detroit Section and member ex-officio; and Mrs. Paul W. Thompson, chairman, women's committee.

MONDAY, JUNE 17

9:30 a.m.

Oil and Gas Power (I)

Gas Turbine Patents, by E. M. Fernald, professor of mechanical engineering, Lafayette College, Easton, Pa.

European Gas Turbine Developments, by S. A. Tucker, McGraw-Hill Publishing Company, Inc., New York, N. Y.

Recent Brown, Boveri Developments of the Gas Turbine, by P. R. Sidler, Brown, Boveri and Company, Limited, New York, N. Y.

GRISWOLD STREET, BUSINESS SECTION OF DETROIT, MICH.

12:30 p.m.

General Luncheon

Chairman, D. Robert Yarnall, president, A.S.M.E.

Welcome, by James W. Armour, general chairman, Semi-Annual Meeting.

Scope of Meeting, by James W. Parker, president, Detroit Edison Company, Detroit, Mich.

2:30 p.m.

Aviation (I)

(Joint Meeting With Society of Aeronautical Weight Engineers)

Integrated Program for Weight Control, by Palmer Kelsem, group engineer, The Glenn L. Martin Company, Baltimore, Md.

Civil Air Regulations As They Affect Weight Control, by William H. Downs, engineer, Republic Aviation Corporation, Farmingdale, N. Y.

Air-Line Compromises With Maximum Possible Pay Loads, by William Davies, assistant chief engineer, United Air Lines, Chicago, Ill.

Heat Transfer (I)

Theory of Moving Sources of Heat and Its Applications to Metal Treatments, by D. Rosenthal, professor, department of metallurgy, Massachusetts Institute of Technology, Cambridge, Mass.

The Thermal Design of Evaporative Condensers, by Hugh J. Scullen, consulting engineer, Detroit, Mich.

Temperature Charts for Induction and Constant Temperature Heating, by Michael P. Heisler, Columbia University, New York, N. Y.

Research Committee on Metal Cutting and Cutting Fluids (I) and Production Engineering (I)

Carbide and Other Cutting Metals, by Arch Mason, Ternstedt Division, General Motors Corporation, Detroit, Mich.

Cutter Life Obtained from Carbide Blanks Mechanically Held Versus Brazed to Cutter Blades, by Fred W. Lucht, Carboloy Company, Inc., Detroit, Mich.

Carbide Tooling at New York Naval Shipyard Lieut., by (jg) C. A. Palmer, N. Y. Navy Yard, Brooklyn, N. Y., and J. G. Kenney, New York Navy Yard, Brooklyn, N. Y.

Great Lakes Carriers (I)

Diesel Power of Motorship "Henry Ford II," by Malcolm McLaren, Ford Motor Company, Dearborn, Mich.

The Modern Lake Freighter, by R. C. Stanbrook, marine engineer, Pittsburgh Steamship Company, Cleveland, Ohio.

Machine Design (I)

Application of Tables for Helical Spring Design, by H. F. Ross, United Shoe Machinery Corporation, Beverly, Mass.

High-Speed-Chain Developments, by A. W. Myer, Brown and Sharpe Manufacturing Company, Providence, R. I.

Evaluating Self-Locking Nuts for Industrial Equipment, by Wm. E. Horenburger, Elastic Stop Nut Company of America, Union, N. J.

Inspection Trip

Visit to Hiram Walker Distillery, Walkerville, Canada

5:00 p.m.

Business Meeting

7:00 p.m.

General Dinner

Chairman, D. Robert Yarnall, president A.S.M.E.

Nuclear-Energy Application

Progress Report of A.S.M.E. Committee, Including Statement of the Intended Scope of Its Work and the Opportunities Which Are Facing It, by Alex D. Bailey, vice-president, Commonwealth Edison Company, Chicago, Ill.

Mechanical and Material Problems Involved in the Beneficent Application of Nuclear Energy, by A. L. Baker, M. W. Kellogg Company, New York, N. Y.

The Effect of the McMahon Bill on Nuclear Energy Application, by Senator Brien McMahon, Washington, D. C.

TUESDAY, JUNE 18

9:30 a.m.

Aviation (II) and Oil and Gas Power (II)

Aircraft Gas Turbines for Propeller Drive, by Alan Howard and Dr. C. J. Walker, turbine-generator engineering division, General Electric Company, Schenectady, N. Y.

Combustion and Ignition in Aircraft Gas Turbines, by A. J. Nerad, research laboratory, General Electric Company, Schenectady, N. Y., and W. D. Crater, engineering division, General Electric Company, Los Angeles, Calif.

Power Boost System for Propeller-Drive Gas Turbines, by John Drake, Northrop Hendy Company, Hawthorne, Calif.

Heat Transfer (II)

Symposium on Recent Advances in Furnace and Kiln Technology.

Power (I)

Experiences with Automatic Air Soot Blowers, by Harold L. Smith, mechanical engineer, Buffalo Niagara Electric Corporation, Buffalo, N. Y.

Burning Low-Grade Midwestern Coals on Spreader Stokers with Continuous Ash Discharge, by John M. Drabelle, mechanical and electrical engineer, Iowa Electric Light & Power Company, Cedar Rapids, Iowa.

Production Engineering (II) and Metals Engineering (I)

The Heliarc Welding Process, by H. T. Herbst, development engineer, Linde Air Products Company, Newark, N. J.

Resistance Welding With Storage Batteries, by J. G. Gordon, general manager, Progressive Welder Company, Detroit, Mich.

Great Lakes Carriers (II)

The Great Lakes Bulk Cargo Carrier, by L. A. Baier, professor, University of Michigan, Ann Arbor, Mich.

Self-Unloading Ships, by George B. Palmer, president, Bruce Engineering Development Company, Detroit, Mich.

12:30 p.m.

General Luncheon

Chairman, D. Robert Yarnall, president, A.S.M.E.

Air Transportation and World Understanding, by J. Parker Van Zandt, director of aviation research, The Brookings Institution, Washington, D. C.

2:30 p.m.

Aviation (III) and Instruments and Regulators (I)

Aerial Cameras, by Talbot Abrams, president, Abrams Instrument Corporation, Lansing, Mich.

Radar Photogrammetry, by R. G. Sanders, assistant vice-president, Fairchild Camera and Instrument Corporation, Jamaica, N. Y.

Latest Developments in Aircraft Controls, by R. A. Brown, Minneapolis-Honeywell Regulator Company, Minneapolis, Minn.

Research Committee on Metal Cutting and Cutting Fluids (II)

Effects of Metallurgical Structure on the Machinability of Cast Iron, by Michael Field, research fellow, University of Cincinnati, Cincinnati, Ohio, and A. Stanbury, assistant professor of metallurgical engineering, University of Cincinnati, Cincinnati, Ohio.

The Distribution of Hardness in Chips and Machine Surfaces, by Norman Zlatin and M. E. Merchant, Cincinnati Milling Machine Company, Cincinnati, Ohio.

Cutting Action of Reamers, by T. F. Githens, mechanical engineer, Cleveland Twist Drill Company, Cleveland, Ohio.

Official Notice

A.S.M.E. Business Meeting

THE Semi-Annual Business Meeting of the members of The American Society of Mechanical Engineers will be held on Monday evening, June 17, 1946, at 5:00 p.m. at Hotel Statler, Detroit, Mich., as a part of the Semi-Annual Meeting of the Society.

Production Engineering (III)

High-Frequency Induction Heat-Treating, by H. A. Strickland, Jr., chief engineer, Budd Wheel Company, Detroit, Mich.

High-Frequency Heating of Nonconducting Materials, by Frederick J. Jolly, industrial heating engineer, The Detroit Edison Company, Detroit, Mich.

Oil and Gas Power (III)

The Gas Turbine as a Land Power Unit, by A. D. Hughes, research engineer, steam-turbine department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

Metallurgical Consideration of Gas Turbines, by Norman L. Mochel, Westinghouse Electric Corporation, Philadelphia, Pa.

Control of the Ak Closed-Cycle Gas-Turbine Power Plant, by F. Salzmann, chief engineer, Escher-Wyss Engineering Works, Zurich, Switzerland.

Process Industries (I)

Lubrication and Sludge-Removal Problems of Automotive-Type Engines, by J. Musser Miller, Standard Oil Company, Detroit, Mich.

The Use of Large Steam Ejectors in the Houdry Process, by Philip Treneau, Elliott Company, Jeanette, Pa., and George Kelso, Houdry Process Company, Wilmington, Del.

Inspection Trips

Visit to Great Lakes ore carrier at the Great Lakes Engineering Company

Inspection visit to the Delray Power Station, The Detroit Edison Company

7:00 p.m.

General Dinner

Chairman, D. Robert Yarnall, president, A.S.M.E.

Toastmaster, E. E. Aldrin, Atlas Supply Company, Newark, N. J.

Air Industrial Planning in Postwar Period, by Major General B. W. Chidlaw, deputy commanding general, engineering T-3, Wright Field, Dayton, Ohio.

Industrial Mobilization, by J. Carlton Ward, president, Fairchild Engine and Airplane Corporation, New York, N. Y.

WEDNESDAY, JUNE 19

9:30 p.m.

Automotive (I)

Chrysler Multibank Power Plant for Medium Tanks, by H. T. Woolson, executive engineer, Chrysler Motor Car Corporation, Detroit, Mich.

General Motors Diesel Engines for Ordnance Vehicles, by F. G. Shoemaker, chief engineer, Diesel-engine division, General Motors Corporation, Detroit, Mich.

Research Committee on Metal Cutting and Cutting Fluids (III) and Production Engineering (IV)

The Influence on Tool Life and Power of Chamfer, Nose Radius- and Peripheral Cutting-Edge Angles When Face-Milling 40,000-Psi Cast Iron, by O. W. Boston, professor, University of Michigan, Ann Arbor, Mich., and W. W. Gilbert, professor, University of Michigan, Ann Arbor, Mich.

Specific Studies Pertaining to Tool Wear, Chip Characteristics, and Surface Finish of Free-Cutting Steels, by G. P. Witteman, assistant metallurgical engineer, Bethlehem Steel Company, Bethlehem, Pa.

Aviation (IV) (Noise Control)

Aircraft Acoustical Problems and Possible Solutions, by K. R. Jackman, Consolidated-Vultee Aircraft Corporation, San Diego, Calif.

Aircraft Blanket Acoustical Performance Characteristics, by W. K. Sidwell, Owens-Corning Fiberglas Corporation, Toledo, Ohio.

Power (II)

Internal Cleaning of Boilers With Acid, by Sheppard T. Powell, consulting chemical engineer, Baltimore, Md.

Boiler Design for Extreme Load Variations, by M. H. Kuhner, chief mechanical engineer, Riley Stoker Corporation, Worcester, Mass.

Committee on Education and Training for the Industries (I)

The Graduate Engineer in Smaller Industries, by James C. Peebles, dean of engineering, Illinois Institute of Technology, Chicago, Ill., and Thomas A. Abbott, general manager, Republic Flow Meters Company, Chicago, Ill.

Registration Fee for Non-Members at the 1946 Semi-Annual Meeting

There will be a registration fee of $2 for nonmembers attending the 1946 Semi-Annual Meeting. For nonmembers wishing to attend just one session (except evening sessions or meal meetings) the fee will be $1. This is in accordance with the ruling of the Standing Committee on Meetings and Program.

Members wishing to bring nonmember guests (male) may avoid this fee by writing to the Secretary of the Society before June 1, 1946, asking for a guest-attendance card for the Semi-Annual Meeting. The card, upon presentation by a guest, will be accepted in lieu of the registration fee. Guests are limited to *two per member*.

12:30 p.m.

General Luncheon

Tank Power Plants, by Edward H. Gray, Lieut. Col. Ordnance, chief automotive division, development and proof services, Aberdeen Proving Grounds, Aberdeen, Md.

2:30 p.m.

Automotive (II)

Ford Engines as Developed for Tanks, by P. Ponta, Ford Motor Co., Dearborn, Mich.

Cadillac Twin V-8 Power Plant for Light Tanks, by J. F. Gordon, Cadillac motorcar division, General Motors Corporation, Detroit, Mich.

Materials Handling (I)

Modern Trends in Design and Application of Materials Handling, by Nelson L. Davis, manager, materials-handling machine division, Link Belt Company, Chicago, Ill.

Fuels (I)

Terminal Velocity as the Measurement of Dust Particle Characteristics, by R. B. Foley, American Blower Company, Detroit, Mich.

Panel Discussion on Smoke Abatement, by J. F. Barkley, Bureau of Mines, Washington, D. C.; E. D. Benton, combustion engineer, Louisville & Nashville Railroad Company, Louisville, Ky.; E. B. Brundage, smoke abatement engineer, City of Rochester, N. Y.; W. A. Carter, engineer, Detroit Edison Company, Detroit, Mich.; F. A. Chambers, deputy smoke inspector, City of Chicago, Chicago, Ill.; F. J. Gibbons, acting chief smoke inspector, City of Detroit, Detroit, Mich.; H. F. Hebley, director of research, Pittsburgh, Coal Company, Pittsburgh, Pa.; and W. E. E. Koepler, secretary, Pocahontas Operators Association, Bluefield, W. Va.

Aviation (V) (Variable Speed Drives)

Application of Variable Speed Drives, by Erwin R. Boynton, aeronautics and machine division, General Electric Company, West Lynn, Mass.

Rubber and Plastics (I)

The Rubber Phenolic Cements as Structural Adhesives, authors to be announced

Analysis of Mechanical Properties of Plastic Laminates, by R. K. Witt.

Inspection Trips

River Rouge Plant, Ford Motor Company, Plant of the Ex-Cell-O Corporation

7:00 p.m.

General Dinner

Chairman: D. Robert Yarnall, president A.S.M.E.

Toastmaster: K. T. Keller, president, Chrysler Motor Corporation, Detroit, Mich.

Speaker: General Jacob L. Devers, Commanding General, Army Ground Forces, Washington, D. C.

THURSDAY, JUNE 20

9:30 a.m.

Production Engineering (V) and Metals Engineering (II)

Arc Welding of Alloy Steels, by Robert J. Heusel, Fisher body division, General Motors Corporation, Detroit, Mich.

Photoelastic Investigation of Residual Stresses in Welds, by James J. Ryan, University of Minnesota, Minneapolis, Minn.

Fuels (II)

The Accomplishments of the National Fuel Efficiency Program, by Thomas C. Cheasley, Sinclair Coal Company, Kansas City, Mo.

The Industrial Use of Coal in Germany, by Howard A. Herder, Sahara Coal Company, Chicago, Ill.

The Importance of Size Control in Burning Bituminous Coal (Illustrated with motion pictures), by O. L. Scales, The Enos Coal Mining Company, Indianapolis, Ind.

Rubber and Plastics (II)

Plastics Mold Release, by Earl Ziegler, Dow Chemical Company, Midland, Mich.

Evaluation of Rubber and Like Materials, by J. D. Morron, U. S. Rubber Company, Detroit, Mich.

Student Member Papers

Papers to be provided by Students.

Materials Handling (II)

The Industrial Truck System for Moving and Storing Material Comes of Age, by C. F. Kells, director of the educational program, The Electrical Industrial Truck Association, Chicago, Ill.

Conveyors—Pacemakers for Industry, by J. C. Webb, Webb Conveyor Corporation, Detroit, Mich.

12:30 p.m.

General Luncheon

The Future Engineer, by D. Robert Yarnall, president, A.S.M.E.

2:30 p.m.

Management (I)

Paper, Better Methods and the Future, by Guy Bates, General Motors Corporation, Detroit, Mich.

Research Committee on Metal Cutting and Cutting Fluids (IV) and Production Engineering (VI)

The Results of an Investigation of the Removal of Metals by the Process of Grinding, by R. E. McKee, University of Michigan, Ann Arbor, Mich., R. S. Moore, Quaker Chemical Products Company, Conshohocken, Pa., and O. W. Boston, professor, University of Michigan, Ann Arbor, Mich.

What Is New In Honing, by L. S. Martz, assistant to president, Micromatic Hone Company, Detroit, Mich.

Fluid Meters Research Committee

Pulsation and Its Effect on Flow Meters, by Eric J. Lindahl, Ohio State University, Columbus, Ohio.

Propeller-Type Meters, by I. O. Miner, Builders-Providence, Incorporated, Providence, R. I.

Inspection Trips

Plant of the Plymouth Motor Car Company

Plant of the United States Rubber Company

W. S. Knudsen Elected to Honorary Membership

LIEUT. GEN. WILLIAM S. KNUDSEN, director, General Motors Corporation, and formerly, director general, Office of Production Management, has been elected an honorary member of The American Society of Mechanical Engineers.

The honor will be conferred on Gen. Knudsen at the banquet of the Society, to be held at Hotel Statler, Detroit, Mich., June 19, 1946, during the 1946 A.S.M.E. Semi-Annual Meeting.

Gen. Knudsen was born and educated in Copenhagen, Denmark. He came to the United States in 1900 and became a citizen in 1914. His first job was in a New Jersey shipyard and later, in 1911, he entered the automobile industry. His remarkable talents in the field of production engineering and his prodigious energy won for him the presidency of the General Motors Corporation in 1937.

On the eve of World War II, he was appointed by the President to direct the unprecedented war-production program of the nation and a year later, was elevated to a lieutenant general of the Army. For services brilliantly performed, he was awarded the Distinguished Service Medal.

A.S.M.E. Calendar

of Coming Meetings

June 3–5, 1946
A.S.M.E. Aviation Division Meeting
Los Angeles, Calif.

June 12–15, 1946
A.S.M.E. Oil and Gas Power Division Meeting
Milwaukee, Wis.

June 17–20, 1946
A.S.M.E. Semi-Annual Meeting
Detroit, Mich.

June 21–22, 1946
A.S.M.E. Applied Mechanics Division Meeting
Buffalo, N. Y.

September 16–18, 1946
Industrial Instruments and Regulators Division Meeting With Instruments Society of America
Pittsburgh, Pa.

September 30–Oct. 2, 1946
A.S.M.E. Fall Meeting
Boston, Mass.

October 24–26, 1946
Joint, A.I.M.E. Coal and A.S.M.E. Fuels Division Meeting
Philadelphia, Pa.

December 2–6, 1946
A.S.M.E. Annual Meeting
New York, N. Y.

Presidents' Page

A Telegram to Senator McMahon

Senator Brien McMahon, *Chairman*
Committee on Atomic Energy
Senate Office Building
Washington, D. C.

The undersigned address you as individuals who believe that the greatest possible advantage should accrue to the public welfare from the use of nuclear energy. Our profession has already contributed largely to the development of nuclear energy, several thousand engineers having been associated in engineering responsibilities in the work of the Manhattan District. We know of the destructive use of nuclear energy but our interest is in its greater use for public good.

We agree in general with the provisions of your Senate Bill 1717 as heretofore published. We believe that the Federal administration of all matters dealing with materials fissionable by chain reaction should be in the hands of agencies that are essentially civilian in make-up. We believe that the Federal Government has a responsibility for the safe use of these materials. We believe that the greatest advantage from the use of these materials will be for civilian industrial purposes. In the interest of these greater uses of nuclear energy we believe that the widest opportunity should be given for industrial research under Commission license. All use of nuclear energy for industrial purposes should be under license by the Atomic Commission but with the facilities owned by industry.

In a forward-looking program of the extent required to develop nuclear energy for industrial purposes, it is important that sound judgment in the use of time, money, and material should be applied to the work of the Atomic Commission. Engineers in performing their daily tasks are concerned with economy in the uses of time, money, and material. As reported in recently published amendments to your Bill the inclusion of a Division of Engineering in the Commission meets this need. We appreciate its addition and are confident that the Division will prove its worth and your wisdom in including it.

We appreciate the tremendous responsibility you have undertaken in stating a policy for this Nation to follow in dealing with this new source of useful energy.

W. W. HORNER, *President*
American Society of Civil Engineers
D. ROBERT YARNALL, *President*
The American Society of Mechanical Engineers
WM. E. WICKENDEN, *President*
American Institute of Electrical Engineers
JAMES G. VAIL, *President*
American Institute of Chemical Engineers

(***This telegram was dispatched to Senator McMahon on April 12, 1946.***)

Successful A.S.M.E. Spring Meeting Held at Chattanooga, Tenn.

Southern Industry Is Keynote

THAT the South is forging ahead in American industry was evident at the 1946 Spring Meeting of The American Society of Mechanical Engineers held at the Read House, Chattanooga, Tenn., April 1-3, 1946, where addresses and papers presented at technical sessions and luncheons pointed to higher living standards, better living conditions, more industrial development and research, and better technical education and training in the South.

The interest shown in this convention was demonstrated by the crowd which filled the mezzanine floor of the Read House by five o'clock on Sunday, March 31, the first day of registration.

A buffet supper, displaying the South's hospitality and friendship, was given on Sunday evening in the Sun Room of the Read House, by the local engineers and their wives, to welcome the approximately 175 out-of-towners who had arrived early. Table decorations such as dogwood, lilacs, narcissusses, and spirea gave the affair an authentic southern atmosphere.

Technical Sessions

More than 750 members and guests took part in the 12 sessions at which 38 outstanding engineers, scientists, industrialists, and educators presented 29 individual or joint technical papers on such subjects as atomic energy, aviation, power, fuels, hydraulics, railroads, prime movers, process industries, management, and education and training.

Of these, the Aviation (I) session on private flying held Monday evening, April 1, and Process Industries (II) session held on Wednesday, April 3, were open to the general public. That both of these sessions and all the other sessions were popular was indicated by the capacity crowds which filled the meeting rooms.

At the Aviation (I) session more than 100 heard W. P. Piper, president, Piper Aircraft Corporation, Lock Haven, Pa., speak on the subject, "Personal Aircraft From a Manufacturer's Viewpoint." On the same program John H. Geisse, assistant to Administrator for Personal Flying Development, Civil Aeronautics Administration, Washington, D. C., presented a paper, "Personal Aircraft and Their Effect on the Future."

The Process Industries (II) session was high lighted by a paper presented by Clarence Birdseye, president, Processes, Inc., Gloucester, Mass., entitled, "Streamlining Vegetable Dehydration."

Space does not permit reviewing or even listing all the other papers presented at this meeting; however, as the publication schedules of MECHANICAL ENGINEERING, A.S.M.E. TRANSACTIONS, and the *Journal of Applied Mechanics* permit, many of these papers will be printed with the discussions they occasioned.

Banquet

The main social event of the three-day meeting was the banquet on Tuesday evening, at which E. E. Williams, vice-president, A.S.M.E., Region IV, was the toastmaster. He introduced L. G. Haller, member A.S.M.E., who in a brief address welcomed approximately 350 A.S.M.E. members and guests to Chattanooga. He was followed by President D. Robert Yarnall, who in his address "Engineering and Citizenship," said: "A man is born a citizen but he may become an engineer. Are we who have chosen engineering endowed by birth with good citizenship characteristics? Alas, far from it. Somewhere along the line, with the help of good environment and sound training, there must be built in us a sense of concern, a social conscience, that will not be satisfied with personal success within the bounds of our profession, essential as this is, but will drive us on and out with other citizens; to carry our share of the burdens of the

A.S.M.E GROUP AT THE CHATTANOOGA SPRING MEETING BEFORE GOING ON A SIGHT SEEING TRIP TO LOOKOUT MOUNTAIN, TENN.

(*Left to right*: Roscoe W. Morton; A. C. Chick; D. Robert Yarnall; S. R. Beitler; J. Calvin Brown; Mrs. Yarnall; John E. Younger; Linn Helander; Mrs. McEwan; W. P. Caine; James Winthorpe; Mrs. Morton; R. F. Gagg; T. S. McEwan; Mrs. Sheehan; Erik Oberg; Philip North Mrs. North; R. A. North; Mrs. F. C. Bragg.)

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Chattanooga Spring Meeting in Pictures

[(1) E. E. Williams, vice-president, A.S.M.E. Region IV, as banquet toastmaster, starts the program rolling. (2) C. Hunter, Mrs. Yarnall, President Yarnall, Past-President Alex D. Bailey, and E. W. Greensmith. (Messrs. Hunter and Greensmith, both from Great Britain, enjoy Southern hospitality extended them at the meeting.) (3) R. L. Sweigert, E. E. Williams, and Leslie Zsuffa with group from Georgia Institute of Technology (4) James Ellis, A. R. Stevenson, and I. Melville Stein in serious discussion following the Management Session on Tuesday. (5) Student Meeting, Tuesday, April 2. (6) The Berry Schools Ballad Singers entertain guests at the banquet. (7) Mrs. Eugene O'Brien, Eugene O'Brien, Mrs. Roscoe W. Morton, Mrs. Thomas Ervin, and Mr. Ervin enjoy themselves at Sunday's buffet supper. (8) Duke University is well represented at the Banquet.]

world's sufferings, to assume our constructive part in responsibility for good wholesome government, and to help in making secure those precious freedoms, among them the right without fear to write our letter to the editor."

Entertainment was provided by the Berry Schools Ballad Singers, a chorus of seven young women from Mount Berry Schools, Mount Berry, Ga., and a group of twenty negro singers under the direction of Cleavant Derrick, negro song leader.

The ballad singers were in old-fashioned costumes, with large sunbonnets framing their faces. A spinning wheel, a flax wheel, a reel, and wool carders added to the atmosphere.

The group captured the audience with jubilees and negro spirituals such as "Climbin' up the Mountain," "Didn't It Rain," "Ole Man River," "Down by the Riverside," and many others.

Luncheons

More than 300 members and guests were present at the luncheon, Monday, April 1, the first day of the Spring Meeting. This luncheon was held jointly with the Chattanooga Engineers' Club in the Silver Ballroom of the Read House.

W. J. Davies, Electric Power Board of Chattanooga, Chattanooga, Tenn., acted as toastmaster.

Dr. J. Parker Van Zandt, director, aviation research, Brookings Institution, Washington, D. C., delivered the luncheon address on the topic, "Air Transportation and World Understanding." He said that the establishment of a three-cent passenger-mile fare for air travel "to anywhere" through Federal subsidy would be a "small premium to pay as insurance against future possible aggression."

Dr. Van Zandt advocated a proposal for "air travel fellowships" for individual states. He urged that each state name committees to select fellows, particularly teachers, editors, and others who "are best fitted to influence others toward better international understanding."

He asserted that world peace will depend upon mutual understanding among nations, and that one of the best means of fostering such understanding is by visiting other countries. Dr. Van Zandt said modern air travel of the future, with planes which may exceed 2000 miles per hour, will offer a genuine opportunity for interchange of travel and better understanding among peoples.

The luncheon on Tuesday, April 2, over which Roscoe W. Morton, professor of mechanical engineering, University of Tennessee, presided, was attended by more than 200 engineers and guests.

Penicillin

An interesting address, "Side Lights on Penicillin and Related Substances," was given by Dr. Irvin W. Grote, Chattanooga Medicine Company, Chattanooga, Tenn. He declared that doctors and medical research men have been able to produce more than 65,000,000 individual doses of penicillin since the "miracle drug" was discovered, because of the co-operation of mechanical engineers.

Dr. Grote described methods whereby the penicillin is separated from the waste material of the mold and converted into liquid form.

INSPECTING X-RAY MACHINE AT COMBUSTION ENGINEERING COMPANY, INC., CHATTANOOGA, TENN.

(*Left to right:* H. B. Oatley, A. J. Townsend, James Partington, Lawford H. Fry, John M. Hall, and A. J. Moses)

He also described the manufacture of penicillin tablets, which must be stamped out in extremely dry atmospheres.

He said that many sulfa drugs, considered revolutionary in the field of medicine a few years ago, have been found to be ineffective against many diseases because of resistance built up by indiscriminate use of the drugs.

Dr. Grote warned that unwise use of penicillin for minor ills and inadequate doses for more serious diseases might result in similar ineffectiveness for the new drug. He said that many doctors fear that patients may build up an immunity to the curative effects of the drug if it is taken too often, or unwisely.

Industrial Southeast

At the final luncheon held on Wednesday, April 3, A. W. Harris, Combustion Engineering Company, Inc., Chattanooga, Tenn., was toastmaster.

John P. Ferris, director of commerce department, Tennessee Valley Authority, Knoxville, Tenn., speaking on the subject of "Industrial Development in the Southeast," told the audience that the rate of manufacturing growth in the southeast has recently been greater than in the nation as a whole.

He asserted that the industrial picture of the South is changing and a recent analysis shows that business men are doing something about industrial development and that the people are living somewhat better.

Between 1933 and 1939 the value of manufactured products increased 68 per cent in the 122 counties of the Tennessee Valley watershed. In the United States as a whole the increase during the same years was 53.7 per cent. Income from factory pay rolls increased 56.8 per cent in the same 122 counties, as against 46.5 per cent for the nation.

Mr. Ferris said that there were 405 new manufacturing establishments set up between 1933 and 1943 in an era encompassing the power service area of the T.V.A. as well as the drainage basin of the Tennessee River.

Inspection Trips

Approximately 400 members and guests went on the four regularly scheduled inspection trips which demonstrated to them the industrial activities of Chattanooga. The first trip to Chickamauga dam and power plant, a T.V.A. project, on Monday, April 1, started the official program. Visitors saw the generators, turbines, switchyard, locks, and the spillway section of the dam.

On Tuesday, April 2, a group visited Combustion Engineering Company, Inc. Here visitors saw high-pressure-boiler drums and other pressure vessels in the process of manufacture. Of particular interest to the group were the stress-relieving furnaces, x-ray machines, and bending and flanging presses.

Wednesday, April 3, took the visitors to the Ross-Meehan Foundries, an all-electric steel foundry, where they saw the heat-treating facilities, mechanical cleaning equipment, and steel-castings machinery capable of producing castings weighing up to 10,000 lb.

The last trip on the schedule, also on Wednesday, took the group to the Chattanooga Glass Works, which manufactures all types of bottles. Here visitors inspected the glass furnaces, mixing machines, bottle-forming machines, annealing ovens, and also a department for decorating the outside of bottles after they are formed.

Student Meeting

A large number of students attended the student meeting on Tuesday, April 2, which was conducted under the chairmanship of Risden P. Reece, chairman of Committee on Relations With Colleges.

Following the business meeting the students were greeted by E. E. Williams, vice-president, A.S.M.E., region IV. Ernest Hartford, executive assistant secretary, A.S.M.E., then gave a brief history of student branches, their purposes, type of meetings to hold, and program preparation.

In an inspirational address, President Yarnall emphasized the necessity of organization. He concluded with the statement: "Life is filled with the necessity of making choices. Make good ones."

The general discussion which followed dealt with the subject, "What Can Student Branch Officers and Members Do to Improve the Society?"

In the afternoon the students visited Combustion Engineering Company, Inc.

Women's Activities

An eventful and interesting program was arranged by the Women's Program Committee, for the visitors.

On Monday morning the women accompanied the men on the inspection trip to Chickamauga Dam. A joint luncheon with the engineers followed. The afternoon was spent shopping and visiting antique shops and gift shops.

The high light of Tuesday's program was a visit to McDade's Orchid Gardens on Signal Mountain. This orchid farm is already the largest in the country and represents more than five years of search for various specimens of the rare plants here and abroad.

On Wednesday morning, April 3, all the women went on a sight-seeing trip to Lookout Mountain, which is 1750 ft above Chattanooga. Luncheon was served at the Fairyland Club, with bridge and bingo games following. Nine pairs of nylon stockings were the prizes awarded to the lucky winners.

Committee Members

The credit for the program belongs to the members and wives of the East Tennessee Section who worked hard to make this Spring Meeting a success. All who attended will long remember the hospitality and friendship extended by Prof. Roscoe W. Morton, chairman; L. G. Haller, W. G. Davies, and A. W. Harris of the General Committee; and the members of the subcommittees which consisted of: *Honorary:* J. A. Dodd, chairman, D. H. Guldberg, A. K. Posser, A. M. Hill, T. O. Sills, E. S. Theiss, D. E. Kehoe, Arthur Roberts, Jr., S. L. Stewart, and C. K. Sharp. *Program Committee:* E. C. Chapman, chairman, and J. Marshall Johnson. *Inspection Trips:* A. R. McLain, chairman, R. V. Haller, and H. L. Suplee. *Transportation:* J. Marshall Johnson, chairman, G. M. Sweeney, Alf. Law, and Ed Allen; *Luncheons, Dinners, and Banquets:* T. C. Ervin, chairman, A. T. Secor, and Arthur T. Jones. *Reception:* P. B. Place, chairman, J. Winthorpe, John Gilliam, Arthur Rankin, and Frank Nabors. *Registration:* F. G. Nunne, chairman, F. A. Salmon, W. D. Blake, and H. W. Sawrie. *Hotel and Train Reservations:* Kenneth A. Jones, chairman, Carl Weigel, E. G. Novotny, and J. L. Fergus. *Technical Sessions:* Fred A. Salmon, chairman, Waldemar Rupinski, H. O. Hendrickson, and Stephens M. Merritt. *Entertainment:* D. C. Sherman, chairman, P. B. Place, R. B. Bayston, and A. J. Kelly. *Publicity, Printing and Signs:* Glenn L. Morris, chairman, T. C. Ervin, W. G. Stromquist, and Bart Leiper. *Finance:* George E. Campbell, chairman, A. J. Moses, and F. Ward Reilly.

1946 OFFICERS OF THE A.S.M.E. AT CHATTANOOGA, TENN.

(*Seated left to right:* T. S. McEwan, vice-president, Region VI; Alex D. Bailey, past-president; D. Robert Yarnall, president; E. E. Williams, vice-president, Region IV; *standing, left to right:* S. R. Beitler, vice-president, Region V; A. R. Stevenson, Jr., vice-president, Region III; A. C. Chick, vice-president, Region I; R. F. Gagg, vice-president, Region II; J. Calvin Brown, vice-president, Region VII; and Linn Helander, vice-president, Region VIII.)

Women's Committee

The women's committee was made up of: Mrs. Thomas C. Ervin, chairman, Mrs. A. J. Moses, Mrs. L. G. Haller, Mrs. W. G. Davies, Mrs. R. W. Morton, and Mrs. A. W. Harris.

Actions of the A.S.M.E. Executive Committee

At a Meeting Held at Headquarters, March 26, 1946

A meeting of the Executive Committee of the Council was held in the rooms of the Society, March 26, 1946.

Present at the meeting were: D. Robert Yarnall, chairman, R. F. Gagg, J. N. Landis, A. R. Stevenson, Jr., A. R. Mumford (Sections), K. W. Jappe, Treasurer, C. E. Davies, Secretary, and D. C. A. Bosworth, Controller.

Research Committee

Upon recommendation of the Manufacturing Engineering Committee, it was voted to authorize the organization of a special Research Committee on High-Speed Milling With Carbide-Tipped Tools and to appoint the following personnel to serve on the new committee: Robert Aitchison, L. M. Bach, M. L. Bricker, A. K. Brown, F. W. Conant, W. P. Eddy, Jr., Sol Einstein, E. G. Firth, T. E. Floyd, I. M. Laddon, J. J. Lee, P. M. McKenna, W. G. Robbins, J. L. Trecker, H. F. Vollmer, D. A. Wallace, H. K. Works.

Presentation of Honors

Upon consideration of the following recommendations of the Board of Honors and Awards: (1) that the Board be advised as far in advance as practicable of the places and dates of national meetings; (2) that the Board bear in mind such scheduled meetings when making selections; (3) that when circumstances warrant, presentation of awards and honors be made in the general area of such scheduled meetings; (4) that awards in a given year, which are not made at such scheduled meetings, be presented at the Annual Meeting; and (5) that all awards during a year, regardless of place of presentation, be announced during the Annual Meeting; the Council voted to endorse the recommendations with the understanding that the Board would in no case strip the Annual Meeting of honors, and that awards would not be made solely on the basis of "residence."

Development Fund

Following review of a report received from D. S. Walker, chairman, Development Fund Committee, stating that $105,779 had been collected at a collection cost of $1,296.01 or 1.2 per cent, the Council voted to express its appreciation to Mr. Walker for his efforts in building the Development Fund.

International Congress for Applied Mechanics

It was voted to accept the invitation from the American Secretariat to participate in the Sixth International Congress for Applied Mechanics, tentatively scheduled to be held in Paris, Sept. 22 to 29, 1946, and to delegate to the Applied Mechanics Division the appointment of A.S.M.E. representatives and the arrangement of Society participation in the program.

Institution of Mechanical Engineers

With reference to a communication from Dr. H. L. Guy, secretary, The Institution of Mechanical Engineers, it was noted that 1947 will be the centenary year of the founding of the I.M.E. and that the British engineers are looking forward to the pleasure of having American engineers join them in some of the special functions planned in connection with that celebration.

Appointments

It was voted to confirm the letter-ballot approval of the appointment of Clarke Freeman on the Board of Honors and Awards to serve for a period of five years. It was further voted to approve the following appointments on committees and joint activities:

Power Test Codes Committee No. 18 on Hydraulic Prime Movers, K. W. Beattie, J. D. Scoville, G. T. Abernathy, George R. Rich, and H. S. Van Patter.

Boiler Code Subcommittee on Ferrous Materials, Robert Kulp.

Sectional Committee on Safety Code for Power Presses, and Foot and Hand Presses, Frank J. Paukner.

Committee on Nuclear Engineering Application, Navy Representatives, Admiral T. A. Solberg, Capt. J. B. Cochran.

Committee on Organization of Engineering Profession, W. L. Cisler, George E. Hulse, K. M. Irwin, T. S. McEwan, and P. T. Onderdonk.

National Management Council, R. C. Knowles (to replace Wallace Clark as alternate, one year).

Joint Committee on Organization of Engineering Profession, W. L. Cisler.

Industry Advisory Council to Federal Specifications Board, Treasury Department, C. B. LePage.

American Academy of Political and Social Science, 50th Anniversary, R. L. Goetzenberger, J. J. McCarthy, and D. W. R. Morgan.

Honorary Chairman of Student Branches, Appointments: Daniel K. Wright, Case School of Applied Science; Robert A. Thompson, University of Florida; A. O. Lee, University of Minnesota; H. P. Neal, Mississippi State College; T. G. Beckwith, University of Pittsburgh; George E. Peterson, Polytechnic Inst. of Brooklyn; Huber O. Croft, State University of Iowa; and Simeon T. Hart, Syracuse University.

Reappointments: C. H. Hixon, Alabama Polytechnic Institute; M. L. Thornburg, University of Arizona; Thomas C. Cooke, Duke University; Frederick H. Thomas, University of Tennessee; David A. Fisher, Tufts College; and Kenneth J. Moser, Stevens Institute of Technology.

G. Ross Lord Honored by Canadian Engineers

G. ROSS LORD, member A.S.M.E., professor of mechanical engineering, University of Toronto, Toronto, Ont., Can., has been elected president of the Association of Professional Engineers of the Province of Ontario for 1946. The Association has a membership of approximately 7000 members and students and is the largest organization of professional engineers in Canada.

G. ROSS LORD

In 1932 Professor Lord was awarded the Freeman Travel Scholarship of The American Society of Mechanical Engineers and spent one year in Germany studying at engineering colleges in Berlin, Munich, and Karlsruhe.

Associated for many years with the Hydro-Electric Power Commission of Ontario on hydraulic studies, Professor Lord at the present time is serving as hydraulic consultant to the Department of Planning and Development of the Ontario Government.

Award for Engineering Teachers Established by S.P.E.E.

A NEW award of $1000 to be known as the George Westinghouse Award in Engineering Education will be given annually by the Society for the Promotion of Engineering Education to the college or university teacher adjudged to have contributed most to the successful teaching of engineering students.

Made possible by the Westinghouse Educational Foundation, the award was established to commemorate the 100th anniversary of the birth of George Westinghouse.

The presentation of the first award will take place at the annual dinner of the S.P.E.E., Saturday, June 22, 1946, in the Jefferson Hotel, St. Louis, Mo.

Aid of Engineers Sought by Surgeons

Medical Applications of Mechanical Engineering

BRANDING the prosthetic devices used by the medical profession today as antique hangers-on from the eighteenth century, Charles M. Gratz, M.D., fellow, American College of Surgeons, called upon the engineering profession to contribute engineering methods and talent to the task of developing more efficient artificial limbs and braces for the wounded veterans of the nation. He spoke on "Medical Applications of Mechanical Engineering" before 25 members and guests of the Junior Group of the Metropolitan Section at a dinner meeting, March 19, 1946, at Child's Restaurant, New York, N. Y.

Speaking on the same subject, chairman A.S.M.E. Committee on Biomechanics, Frederick Teichman, professor of aeronautical engineering, Daniel Guggenheim School of Aeronautics, New York University, New York, N. Y., expressed the willingness of engineers to co-operate with doctors in the solution of medical problems of a mechanical nature. He said that when doctors agree on specific problems it will be the responsibility of the engineers to apply engineering principles and methods to the solution of these problems.

Dr. Gratz spoke on the complexity of the knee and showed the inadequacy of the prosthetic devices in use today designed to perform the function of the knee. Using the left knee of John L. Lewis, junior member A.S.M.E., The Babcock and Wilcox Company, as a model, Dr. Gratz pointed out the major muscles and explained their mechanical function. In view of the numerous leg amputations resulting from World War II, Dr. Gratz stated that an efficient mechanical knee was the greatest need among prosthetic devices. The magnitude of this need posed a problem worthy of the best talents of both the medical and the engineering professions.

In the discussion period that follow the talks, George A. Stetson, editor, MECHANICAL ENGINEERING, commented on the development of the typewriter from an awkward mechanism in its first designs to the efficient machine it is today and said that although the first mechanical knee designed may not be the final answer, continued development by both professions might produce a mechanism closely approaching the performance of a human knee.

Reclamation Magazine Resumes Publication

THE Bureau of Reclamation will resume publication of its monthly magazine *The Reclamation Era*. The first issue, since suspension of publication in 1942, will be available in May, 1946. The magazine contains information on engineering developments in the field of reclamation, government policy on reclamation activities, and opportunities for employment on Bureau of Reclamation projects.

The subscription rate is $1 per year.

Record A.S.M.E. Aviation Division Annual Meeting to Be Held at Los Angeles Campus, University of California, June 3 to 6, 1946

THE LARGEST annual meeting ever to be held by the Aviation Division of The American Society of Mechanical Engineers will take place June 3 to 6, 1946, at the Los Angeles Campus of the University of California.

Technical Sessions

More than twenty technical sessions are planned on applied mechanics, heat transfer, management, production, gas turbines, instruments and regulators, hydraulics, metals engineering, fuels and lubricants, and rubber and plastics—all pertaining more or less to the field of aviation.

The general session on Monday evening, June 3, in Royce Hall auditorium will be one of the high lights of the meeting. Major General B. W. Chidlaw, deputy commanding general, engineering (T-3), Headquarters, Air Materiel Command, will speak on "Air Industrial Planning in Postwar Period," and J. Carlton Ward, Jr., president, Fairchild Engine and Airplane Corporation, New York, N. Y., will speak on "Industrial Mobilization." A capacity audience of 1500 is expected for this session.

Aviation Meeting Committee

Timothy E. Colvin is general chairman of the committee in charge of the meeting.

Members of the Honorary Advisory Committee are: Major General Ralph P. Cousins, Dr. Robert A. Millikan, Donald W. Douglas, Rear-Admiral E. M. Pace, Dr. Clarence A. Dykstra, and Dr. Robert G. Sproul.

L. M. K. Boelter, dean, college of engineering, University of California, is serving as chairman of the Program Committee. Assisting him are the following committees: *Heat Transfer*, W. W. Reaser, H. S. Gordon, R. C. Martinelli, B. L. Messinger, Fred Boeke; *Rubber and Plastics*, John Delmonte, Erich Marx; *Production and Tooling*, J. C. Dillon, F. R. Adler, Clifford Bell, N. A. Lombard, Walter DelMar; *Applied Mechanics*, J. E. Younger, D. E. Hudson, W. H. Shallenberger, E. M. Wagner; *Metals Engineering*, William Schroeder, Erich Thomsen; *Instruments and Regulators*, S. G. Eskin, M. J. Zucrow, Walter Trautman; *Management*, V. L. Peickii, R. F. O'Mara, L. R. Barrett; *Hydraulic*, J. W. Daily, Aladar Hollander, Ralph Middleton, Paul L. Armstrong; *Fuels and Lubricants*, Homer Reed, J. S. Gallagher, C. M. Sandland.

The Arrangements Committee consists of W. E. Mason, chairman, W. L. Orr, J. C. Dillon, and Bruce E. DelMar.

The Executive Committee of the Southern California Section is headed by Ray G. Roshong, chairman.

F. K. Teichmann is chairman of the A.S.M.E Aviation Division and J. E. Younger is secretary of the division.

A preliminary program of the meeting follows:

MONDAY, JUNE 3

7:30 p.m.

General Session

Royce Hall

Chairman: L. M. K. Boelter, dean of engineering, University of California, Los Angeles, Calif.

Assistant Chairmen: Wesley L. Orr and John C. Dillon, college of engineering, University of California, Los Angeles, Calif.

Air Industrial Planning in Postwar Period, by B. W. Chidlaw, major general, deputy commanding general, engineering (T-3), Headquarters, Air Materiel Command.

Impact of Industrial Mobilization on Aircraft Industry, by J. Carlton Ward, Jr., president, Fairchild Engine and Airplane Corporation, New York, N. Y.

TUESDAY, JUNE 4

7:00 p.m.

Aviation—Production and Metals

Chemistry Building, Room 45

Chairman: Wesley L. Orr, department of engineering, University of California, Los Angeles, Calif.

Assistant Chairman: Clifford Bell, department of mathematics, University of California, Los Angeles, Calif.

Recent Development in Steel Forgings, by Waldemar Naujoks, chief engineer, Steel Improvement and Forge Company, Cleveland, Ohio.

Fabrication of Steel Components by the Method of Copper Brazing, by R. W. Steenrod, district heating specialist, General Electric Company, Los Angeles, Calif.

7:00 p.m.

Aviation—Gas Turbines

Chemistry Building, Room 19

Chairman: M. J. Zucrow, executive engineer, Aerojet Engineering Corporation, Azusa, Calif.

Assistant Chairman: Bruce E. DelMar, Douglas Aircraft Company, Santa Monica, Calif.

Combustion and Ignition in Aircraft Gas Turbines, by A. J. Nerad and W. D. Crater, General Electric Company, Los Angeles, Calif.

Characteristics of Jet Engines at High Flight Speeds, by C. A. Meyer, Westinghouse Electric Corporation, Lester, Pa.

7:00 p.m.

Aviation—Applied Mechanics

Chemistry Building, Room 134

Chairman: D. E. Hudson, California Institute of Technology, Pasadena, Calif.

Assistant Chairman: E. M. Wagner, 1165 Lorain Avenue, San Marino 9, Calif.

Aircraft Photoelastic Ventures, by D. O. Horning, engineer, Consolidated-Vultee Aircraft Corporation, San Diego, Calif.

Bending Rigidity and Column Strength of Thin Sections, by Paul E. Sandorff, research engineer, Lockheed Aircraft Corporation, Burbank, Calif.

7:00 p.m.

Aviation—Instruments and Regulators

Chemistry Building, Room 234

Chairman: J. E. O'Hagan, Grayson Heat Control, Limited, Lynwood, Calif.

Assistant Chairman: H. W. Rice, Robertshaw Thermostat Company, Los Angeles, Calif.

Instrumentation for Rocket Motors and Jet Assisted Take-Off, by T. H. Wiancko, development engineer in charge of instrumentation, Aerojet Engineering Corporation, Azusa, Calif.

High Speed Multipoint Temperature Recorder, by T. M. Blackmon, electrical research engineer, research laboratory, Douglas Aircraft Company, Santa Monica, Calif.

Gyrostabilizer Analysis With the Mechanical Transient Analyzer, by G. D. McCann, electronics engineering department, and S. W. Herwald, miscellaneous engineering department, Westinghouse Electric Corporation, East Pittsburgh, Pa.

7:00 p.m.

Aviation—Heat Transfer

Chemistry Building, Room 310

Chairman: H. S. Gordon, radiation laboratory, University of California, Berkeley, Calif.

Assistant Chairman: John Allen, Douglas Aircraft Company, Inc., Santa Monica, Calif.

7:00 p.m.

Aviation—Hydraulics

Chairman, Richard G. Folsom, associate professor of mechanical engineering, University of California, Berkeley, Calif.

Assistant chairman, John M. Wild, aerodynamist, Northrop Aircraft, Incorporated, Hawthorne, Calif.

The High-Speed Water Tunnel at the California Institute of Technology, by R. T. Knapp, associate professor of hydraulics, and director of hydrodynamics laboratory, California Institute of Technology, Pasadena, Calif.

Water-Tunnel Measurements of the Infinite-Aspect-Ratio Characteristics and Cavitation Characteristics of the N.A.C.A. 4412 Hydrofoil Section, by James W. Daily, hydraulic engineer and instructor in mechanical engineering, California Institute of Technology, Pasadena, Calif.

A New Method of Determining the Inside Air-Flow Distribution for Heat Anti-Icing on Airfoil Surface, by Julius M. Naiman, Hollywood, Calif.

The Use of a Hot-Air Boundary Layer for Exterior Heating of Windshields, by H. H. Hanger and T. P. Jackson, Air Service Technical Command, Equipment Laboratory, Wright Field, Dayton, Ohio

Compartment Cooling of Airplanes, by Al Mayo, Douglas Aircraft Company, Incorporated, El Segundo, Calif.

7:00 p.m.

Aviation—Fuel and Lubricants

Chemistry Building, Room 340

Chairman: C. M. Sandland, C. F. Braun and Company, Alhambra, Calif.

Assistant Chairman: To be announced

Additive-Type Lubricating Oils for Aircraft Engines, by W. E. Kuhn, The Texas Company, New York, N. Y.

Aviation Greases, by L. W. McLennan and Dr. Earl Amott, Union Oil Company, Oleum, Calif.

WEDNESDAY, JUNE 5

7:00 p.m.

Aviation—Rubber and Plastics

Co-sponsored by S.P.I.

Chemistry Building, Room 45

Chairman: R. B. Stringfield, consulting engineer, Los Angeles, Calif.

Assistant Chairman: L. R. Barrett, chief engineer, Ellinwood Industries, Los Angeles, Calif.

New Materials in Relation to Motor Vehicle Construction, by Fred Selje, consulting engineer.

Mechanical Applications of Latex Dip Coatings, by Fred Werner, chief chemist, Reeves Rubber Company, Los Angeles, Calif.

7:00 p.m.

Aviation—Production

Chemistry Building, Room 19

Chairman: Walter DelMar, Douglas Aircraft Company, Santa Monica, Calif.

Assistant Chairman: Frank Adler, Adel Precision Products Company, Los Angeles, Calif.

Production Processing of 75S-T Aluminum. A panel discussion.

Panel Members: D. M. Finch, department of engineering, University of California, Berkeley, Calif.; Tim P. Glenn, tool engineer, Douglas Aircraft Company, Santa Monica, Calif.; F. R. Kostick, metallic materials group leader, process group, North American Aviation, Incorporated, Inglewood, Calif.; Thomas E. Piper, chief, materials and process engineering, Northrop Aircraft Corporation, Hawthorne, Calif.; and L. D. Bonham, engineer, process department, Lockheed Aircraft Corporation, Burbank, Calif.

7:00 p.m.

Aviation—Management

Chemistry Building, Room 134

Chairman: V. L. Peickii, manager, tool engineering, Lockheed Aircraft Corporation, Burbank, Calif.

Assistant Chairman: R. F. O'Mara, Western Precipitation Corporation, Los Angeles, Calif.

Wage Incentives; Important Factors Frequently Overlooked, by P. B. Crouse, consulting management engineer, The Crouse Company, Pasadena, Calif.

7:00 p.m.

Aviation—Metals

Chemistry Building, Room 234

Chairman: E. G. Thomsen, department of mechanical engineering University of California, Berkeley, Calif.

Assistant Chairman: Stanley Hall, design engineer, plant engineering department, plant A-1, Lockheed Aircraft Corporation, Burbank, Calif.

Fracture of Some Aluminum Alloys Under Combined Stress, by D. M. Cunningham, division of mechanical engineering, University of California, Berkeley, Calif.

Dynamic Testing of Engineering Materials, by Donald Clark, professor, department of mechanical engineering, California Institute of Technology, Pasadena, Calif.

Metallurgical Consideration in Aircraft Gas Turbines, by N. L. Mochel, Westinghouse Electric Corporation, Ridley Park, Pa.

7:00 p.m.

Aviation—Heat Transfer

Chemistry Building, Room 310

Chairman: B. L. Messinger, Lockheed Aircraft Corporation, Burbank, Calif.

Assistant Chairman: Carl Richardson, California Institute of Technology, Pasadena, Calif.

A Survey of German Reports on Thermal Anti-Icing, by M. Tribus, engineering department, University of California, Los Angeles, Calif.

A Correlation of Measured and Predicted Flow Characteristics of an Aircraft Ram Air-Duct System, by G. T. Rowe, Santa Monica, Calif.

Heat Requirements for Anti-Icing a Radar Housing, by H. H. Hauger, Air Technical Service Command, Equipment Laboratory, Wright Field, Dayton, Ohio; or alternate paper, The Control of Structural Temperatures in Jet-Propelled Aircraft, by A. Blackstone, North American Aircraft, Inglewood, Calif.

7:00 p.m.

Aviation—Applied Mechanics

Chemistry Building, Room 340

Chairman: S. F. Duncan, associate professor of mechanical engineering, University of California, Los Angeles, Calif.

Assistant Chairman: Paul E. Sandorff, research engineer, Lockheed Aircraft Corporation, Burbank, Calif.

Shaking Aircraft Wings in Flight, by R. L. Reed, engineer, Consolidated-Vultee Aircraft Corporation, San Diego, Calif.

Rotational Drop-Testing of Airplane Main Landing Gears, by William H. Gayman, formerly research engineer, Lockheed Aircraft Corporation, Burbank, Calif.

The Fan System of the Co-Operative Wind Tunnel, by Harold F. Richards, California Institute of Technology, Pasadena, Calif.

7:00 p.m.

Aviation—Instruments and Regulators

Chairman: A. B. Carder, chief engineer, experimental flight-test division, Douglas Aircraft Company, Mines Field, El Segundo, Calif.

Assistant Chairman: Fred Garrison, district meter and instrument specialist, General Electric Company, Los Angeles, Calif.

Instrumentation for Helicopters, by C. F. Savage and R. G. Jewell, design engineers, aeronautical instrument engineering division, General Electric Company, West Lynn, Mass.

Instrumentation for Jet-Propelled Planes, by C. A. Edman, engineer, aeronautical instrument engineering division, General Electric Company, West Lynn, Mass.

THURSDAY, JUNE 6

7:00 p.m.

Aviation—Rubber and Plastics

Co-sponsored by S.P.I.

Chemistry Building, Room 45

Chairman: John Delmonte, technical director, Plastics Industries Technical Institute, Los Angeles, Calif.

Assistant Chairman: To be announced

Cost-Estimating Procedures for Molded Parts, by M. Carmien, chief engineer, New Plastics Corporation, Los Angeles, Calif.

Laminated Edge Attachment for Acrylics, by E. H. Snyder, research engineer, Lockheed Aircraft Corporation, Burbank, Calif.

Sandwich Laminates With Medium-Density Cores, by Jack Williamson, chief engineer, Glenn H. Taylor Company, Los Angeles, Calif.

7:00 p.m.

Aviation—Production Tooling

Chemistry Building, Room 19

Chairman: Timothy E. Colvin, president, Aerco Corporation, Hollydale, Calif.

Assistant Chairman: Frank Adler, Adel Precision Products Company, Los Angeles, Calif.

Reconversion Problems in Aircraft Tooling, by Nathaniel A. Lombard, Douglas Aircraft Company, Santa Monica, Calif.

Aircraft Moving Assembly Lines, by T. S. Christin, Douglas Aircraft Company, Santa Monica, Calif.

7:00 p.m.

Aviation—Management

Chemistry Building, Room 134

Chairman: V. L. Peickii, manager, tool engineering, Lockheed Aircraft Corporation, Burbank, Calif.

Assistant Chairman: L. R. Barrett, 2240 North Side Drive, Montebello, Calif.

Cost Control, by P. C. Hamlin, National Supply Company, Torrence, Calif.

Engineering Research Laboratory Management, by Maurice Nelles, Lockheed Aircraft Corporation, Burbank, Calif.

Management and Efficiency, by Harry W. Case, 3633 West 104th Street, Inglewood, Calif.

7:00 p.m.

Aviation—Instruments and Regulators

Chemistry Building, Room 234

Chairman: M. J. Zucrow, Aerojet Engineering Corporation, Azusa, Calif.

Assistant Chairman: M. J. Caparone, Grayson Heat Control, Limited, Los Angeles, Calif.

Characteristics of Aircraft Electrical Systems, by J. C. Cunningham, industry engineering department, Westinghouse Electric Corporation, East Pittsburgh, Pa.

Electrical Snap-Action Temperature Control for Aircraft, by J. R. Campbell, consulting engineer, The Paul Henry Company, Los Angeles, Calif.

7:00 p.m.

Aviation—Heat Transfer

Chemistry Building, Room 310

Chairman: R. C. Martinelli, department of mechanical engineering, University of California, Berkeley, Calif.

Assistant Chairman: William Flaherty, jet-propulsion laboratory, California Institute of Technology, Pasadena, Calif.

Symposium on Heat-Anti-Icing, participating speakers from: Air Service Technical Command, National Advisory Committee for Aeronautics, airframe manufacturers, aircraft-accessory manufacturers, Civil Aeronautics Administration, and the air lines.

7:00 p.m.

Aviation—Metals Engineering

Chemistry Building, Room 340

Chairman: William Schroeder, research engineer, Lockheed Aircraft Corporation, Burbank, Calif.

Assistant Chairman: W. H. Arata, design engineer, production design development group, Lockheed Aircraft Corporation, Burbank, Calif.

Elevated-Temperature Stretch-Flanging of Some Aluminum Alloys, by E. G. Thomsen, assistant professor of mechanical engineering, University of California, Berkeley, Calif.

High-Strength Light Alloys in Aircraft and Their Artificial Aging, by Stewart Martin, Consolidated-Vultee Aircraft Corporation, San Diego, Calif.

7:00 p.m.

Aviation—Hydraulics

Chairman, C. A. Gongwer, Aerojet Engineering Corporation, Azusa, Calif.

Assistant chairman, Fred O. Hosterman, hydraulics design specialists, Lockheed Aircraft Corporation, Burbank, Calif.

High-Pressure High-Altitude Aircraft Hydraulic-System Pumps, by C. S. Sorensen, chief engineer, aviation manufacturing division, Filfillan Brothers, Incorporated, Los Angeles, Calif.

Use of Hydraulic Analogies for Studying Wave Phenomena in Gases, by R. T. Knapp, associated professor of hydraulics and director of hydrodynamics laboratory, California Institute of Technology, Pasadena, Calif., and H. A. Einstein, hydraulics engineer, hydrodynamics laboratory, California Institute of Technology, Pasadena, Calif.

Objectives and Personnel of the E.J.C. Committee on the Economic Status of the Engineer

THE economic status of engineers, particularly the status of young engineers who have attained or are training for professional status, is under study by three fact-finding subcommittees of the Committee on the Economic Status of the Engineer organized by the Engineers' Joint Council.

The professional societies co-operating in the Committee on the Economic Status of the Engineer are: American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Institute of Chemical Engineers, and the National Society of Professional Engineers.

Engineering Graduates

Three specific phases of the general problem are under consideration. The matter of company policies and attitudes pertaining to the selection, training, placement, advancement, guidance, and professional activities of graduate engineering employees, but not the matter of compensation, is under study by the Committee for Survey of Employer Practice Regarding Engineering Graduates. A carefully selected group of industrial employers is co-operating in this study. Serving on the committee are: E. G. Bailey, chairman; A.S.M.E.; L. W. Bass, A.I.Ch.E.; William N. Carey, A.S.C.E.; F. B. Foley, A.I.M.E.; R. C. Muir, A.I.E.E.; and H. T. Woolson, A.S.M.E.

The Engineering Profession

Facts of a personal nature reflecting the economic status of the engineer, such as educational level, years engaged in practice, branch of engineering, field of specialization, annual income, and similar information, is the concern of the Committee on Survey of the Engineering Profession. By means of a precoded series of questions addressed directly to about 100,000 member engineers of the co-operating societies, the Committee plans to obtain valuable information, which it will submit to an expert consultant for analysis and later prepare for distribution to all members of the co-operating societies. The committee is composed of the following: William N. Carey, chairman, A.S.C.E.; L. W. Bass, A.I.Ch.E.; E. G. Bailey, A.S.M.E.; Mark Eldredge, A.I.E.E.; and Ernest W. Ellis, A.I.M.E.

Collective Bargaining

The problem of collective bargaining as it affects or may affect engineers in professional work or in training for professional work is under study by the Committee on Collective Bargaining by Engineers in Professional Work. This committee is compiling a manual on the subject which it hopes will be accepted and published jointly by the co-operating societies. Members of the committee are: E. P. Yerkes, chairman, A.I.E.E.; William N. Carey, A.S.C.E.; J. M. Church, A.I.Ch.E.; C. S. Gotwals, A.S.M.E.; and L. E. Young, A.I.M.E.

Other members of the Committee on the Economic Status of the Engineer are: John S. Kennedy, N.S.P.E.; C. S. Proctor, A.S.C.E., William F. Ryan, N.S.P.E.; E. J. Stocking, A.S.C.E.; A. C. Streamer, A.I.E.E.; Scott Turner, A.I.M.E.; S. L. Tyler, A.I.Ch.E.; and Alex Van Praag, Jr., N.S.P.E.

A preliminary report on the work of the Committee on the Economic Status of the Engineer made by I. M. Stein, chairman, member, A.S.M.E., during the 1945 A.S.M.E. Annual Meeting was reported on page 60 of the January, 1946, issue of MECHANICAL ENGINEERING.

Management Congress Postponed

THE Eighth International Management Congress, scheduled to have been held in Stockholm, Sweden, Aug. 31 to Sept. 5, 1946 (see MECHANICAL ENGINEERING, April, p. 384), has been postponed.

Wood Industries Plan to Co-Ordinate Research

A CONFERENCE held in Madison, Wis., in March, 1946, may produce far-reaching results in the woodworking industries. A number of producers and users of wood met under the leadership of Samuel T. Dana, dean, school of forestry, University of Michigan. It was their conviction that there is a need for a national over-all organization that would include professional, educational, technical, and trade interests in the broad field of research in wood utilization. The purpose of such an organization would be to interchange and consolidate information and data in this field, and to make it available in a more comprehensive form.

A temporary committee was appointed under the leadership of Bror L. Grondal, school of forestry, University of Washington, with the responsibility of suggesting and developing a permanent organization to carry forward this

project. This committee consists of: George A. Garratt, dean, Yale University School of Forestry, New Haven, Conn.; William J. Baker, Forest Products Laboratory, Madison, Wis.; Broder F. Lucas, University of Arkansas, Fayetteville, Ark.; Ralph W. Hayes, department of forestry, Louisiana State University, Baton Rouge, La.; P. B. Proctor, school of forestry, Oregon State College, Corvallis, Ore.; Stanley Fontanna, Michigan Planning Commission, Lansing, Mich.; H. S. Newins, school of forestry, University of Florida, Gainesville, Fla.

University of Pennsylvania Acquires New Laboratory

THE Central Engineering Laboratory, established by the government in the Towne Scientific School of the University of Pennsylvania for wartime research and development, has been converted into the University of Pennsylvania Thermodynamics Research Laboratory.

According to John A. Goff, member A.S.M.E., dean, Towne Scientific School, and Whitney professor of mechanical engineering, the main objectives of the new laboratory are (1) to foster fundamental research in the thermodynamic properties of substances used in engineering processes and to apply new knowledge to the improvement of these processes; (2) to build a strong program of graduate study and research in thermodynamic and related fields; and (3) to co-operate with industry in the investigation of practical problems which require use of the extensive facilities of the laboratory for the production of liquid air, liquid oxygen, and liquid nitrogen.

At the present time the laboratory is working on eighteen research projects sponsored by the Navy. The laboratory employs 52 persons, two of whom are linguists engaged in the translation of seized German documents on the subject of oxygen production.

University of Iowa Offers Course in Management

A THREE-WEEKS' course in management devoted to production planning, plant layout, motion and time study, wage incentives, and related subjects intended for plant managers, foremen, industrial engineers, methods and time-study analysts, cost accountants and office executives, will be given for the eighth year by the University of Iowa, Iowa City, Iowa, June 10 to June 28, 1946.

A sixteen-page bulletin describing the course may be obtained by writing to The State University of Iowa, College of Engineering, Iowa City, Iowa.

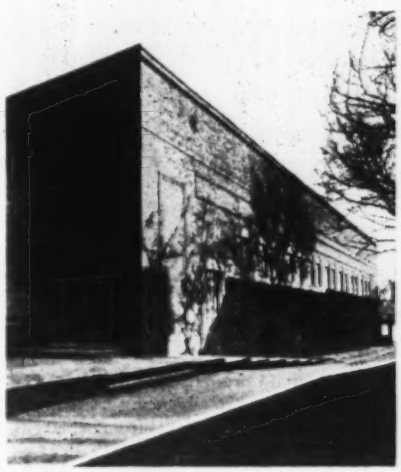
Welding Practices Listed by A.W.S.

A 47-PAGE compilation of recommended practices for the spot- and seam-welding of low-carbon, stainless, and hardenable steels, nickel, monel, and inconel; the projection-welding of low-carbon and stainless steels; flash-butt welding low- and medium-strength forging steels; and the standard methods for testing resistance welds has been published by the American Welding Society.

Copies may be obtained from the American Welding Society, 33 West 39th Street, New York 18, N. Y.

Cleveland, Ohio, Site of New A.S.H.V.E. Laboratory

A LARGE two-story auditorium-type building 58 ft × 125 ft has been purchased by the American Society of Heating and Ventilating Engineers to serve as the Society's new research laboratory. The building is located at 7218 Euclid Avenue, Cleveland, Ohio, and will provide adequate research facilities for serving the entire heating, ventilating, and air-conditioning industry.



A.S.H.V.E. LABORATORY, CLEVELAND, OHIO

Three large rooms with 11-ft ceilings and numerous small service rooms totaling 5300 sq ft are available on the ground floor, while the second floor of the heavily reinforced structure contains 4600 sq ft of floor space with 18-ft headroom completely free of any obstruction.

To the rear of the building where an unshaded area 85 ft × 300 ft is available, the A.S.H.V.E. plans to erect equipment for study of solar radiation and associated problems.

Cyril Tasker, director of research is in charge of the laboratory. He is assisted by C. M. Humphreys, H. B. Nottage, G. V. Parmelee, and Dr. A. D. Brandt.

A. C. Streamer Honored

THE honorary degree of Doctor of Engineering was conferred upon A. C. Streamer, member A.S.M.E., vice-president, Westinghouse Electric Corporation, Pittsburgh, Pa., on Feb. 22, 1946, by the University of Colorado, Boulder, Colo., where he completed his undergraduate studies.

1946 A.S.H.V.E. Guide Available

THE twenty-fourth edition of the Heating Ventilating Air Conditioning Guide published by the American Society of Heating and Ventilating Engineers, 51 Madison Ave., New York, N. Y., is just off the press. The technical text contains 51 chapters grouped under the general section headings of principles, human reaction to atmospheric environment, heating and cooling loads, combustion and consumption of fuels, heating systems and equipment, air conditioning, special applications, and installation and testing codes.

The Guide contains 904 pages of technical text and 376 pages of equipment data and was prepared by 42 members of the A.S.H.V.E. with other organizations co-operating.

Gen. G. M. Barnes Receives Elliott Cresson Medal

THE 1946 Elliott Cresson Gold Medal of The Franklin Institute was presented to Gladeon M. Barnes, member A.S.M.E., major general, U. S. Army, chief of the research and development service, Office of the Chief of Ordnance, U.S. Army Service Forces, at the annual medal-day ceremonies of the Institute in Philadelphia, Pa., April 17, 1946.

General Barnes received the award "in consideration of his notable contributions to the design and development of numerous ordnance items, particularly antiaircraft guns, tanks, and seacoast artillery; for his early development of welded gun carriages; and for his masterly organization of ordnance research, closely articulated with development and production."

The Cresson Medal of The Franklin Institute was established in 1848. It is presented for discovery or original research, adding to the sum of human knowledge, irrespective of commercial value. Among the earlier recipients of the Cresson Medal are Professor and Madame Curie, Rudolf Diesel, Alexander Graham Bell, Orville Wright, Carl Steinmetz, and Lee de Forest.

Sanford A. Moss to Receive Potts Medal

THE Potts Medal of The Franklin Institute was awarded to Dr. Sanford A. Moss, fellow A.S.M.E., Holly Medalist, 1945, according to an announcement by Dr. Henry Butler Allen, secretary and director of the Institute. Dr. Moss, consulting engineer for the General Electric Company, will receive the award "in consideration of the extreme value of his work in making a turbosupercharger a successful and reliable part of an internal-combustion engine."

Established in 1906, the Howard N. Potts Gold Medal is awarded for distinguished work in science or the arts, important development of previous basic discoveries, inventions or products of superior excellence or utilizing important principles.

Education Department Established by Westinghouse

AN EDUCATION department has been established by the Westinghouse Electric International Company to facilitate the technical education of trainees from China and Mexico in accordance with recent agreements with those countries and to consolidate other educational activities of the company.

The new department will be the liaison agency in the training of 300 students selected by the National Resources Commission of China over a period of five years and 200 trainees to be picked by the Industria Electrica de Mexico. Trainees will attend the student engineering course, but the education department will handle all matters short of the actual training, in conjunction with special representatives of the company responsible for the projects.

The department will also help to select other foreign students for training in the student engineering course and will aid in picking future engineers for the Westinghouse Electric International Company from American students completing the course.

A.S.M.E. Secretary Visits Virginia Student Branches

WHILE returning from the A.S.M.E. Spring Meeting at Chattanooga, Tenn., C. E. Davies, secretary, A.S.M.E., accepted the invitation to speak before a joint meeting of the Virginia Section and the Virginia Polytechnic Institute at Blacksburg, Va., April 4, 1946. His subject was "Building a Profession."

On the following day he visited the University of Virginia, Charlottesville, Va., where he addressed a meeting of the student branch on the topic, "A Look Ahead in Mechanical Engineering."

S.E.S.A. Spring Meeting to Be Held in Buffalo, N. Y.

THE Spring Meeting of the Society for Experimental Stress Analysis will be held at Hotel Statler, Buffalo, N. Y., June 24 to 26, 1946. During the meeting a symposium on the fatigue of manufactured parts will be held jointly with the American Society for Testing Materials.

The Annual Meeting of the Applied Mechanics Division of The American Society of Mechanical Engineers will be held at Hotel Sheraton, Buffalo, N. Y., June 21 and 22, 1946. Some members of the A.S.M.E. may prolong their stay in Buffalo in order to attend the technical sessions scheduled for the S.E.S.A. Spring Meeting.

The tentative program of the Annual Meeting of the A.S.M.E. Applied Mechanics Division appears on page 495 of this issue.

Joseph W. Barker New Head of Research Corporation

JOSEPH W. BARKER, member A.S.M.E., has resigned as dean, School of Engineering, Columbia University, New York, N. Y., to accept a position as president of the Research Corporation, New York, N. Y.

James Kip Finch has been appointed to succeed Dr. Barker.

DR. JOSEPH W. BARKER

The Research Corporation is a nonprofit organization devoted to advancing research and technology by use of revenues from patents assigned to it by interested inventors. The Corporation makes grants to institutions at which scientists work and teach. The funds allotted are available for the purchase of needed equipment and for employment of assistants either as fellows or otherwise.

The story of the Research Corporation and its part in postwar collegiate research was published in the November, 1945, issue of MECHANICAL ENGINEERING

The initial list of the Corporation's Special Grants-in-Aid for Postwar Research is published on page 492 of this issue.

1946 Fiftieth Anniversary of N.F.P.A.

THE Fiftieth Anniversary Meeting of the National Fire Protection Association will be held at Hotel Statler, Boston, Mass., June 3 to 7, 1946.

Organized in Boston, Mass., in 1896 as a noncommercial and nonprofit-making association, the N.F.P.A. has become the international clearing house for all information that is authoritative on the subject of fire protection and fire prevention. Its membership includes over 150 organizations in 37 countries and more than 10,000 individuals.

George B. Pegram Speaks at Forum on Atomic Control

DR. GEORGE B. PEGRAM, member A.S.M.E., dean, graduate faculties, Columbia University, New York, N. Y., and member, A.S.M.E. Committee on Nuclear-Energy Application, participated in a dinner forum on "The Common Man in the Atomic Age; Can He Control the Experts?" sponsored by the New School for Social Research, New York, N. Y.

Dr. Pegram said that the common man can help himself best by backing government-sponsored fundamental research conducted by experts. He said that the common man should see that young men and women with scientific aptitudes are provided with an opportunity to develop their abilities and that scientists and experts are provided with equipment and the freedom to conduct fundamental research. Because fundamental research is expensive and international in scope, he said, the interests of the common man can best be served by free and full publication of the results of fundamental research for the benefit of all.

New Secretary Appointed by Stevens Alumni

HAROLD R. FEE, member A.S.M.E., has been appointed secretary of the Alumni Association of Stevens Institute of Technology, Hoboken, N. J. He assumed his new duties on April 1, 1946.

Mr. Fee was associated with Ingersoll-Rand Company, New York, N. Y., and Philadelphia, Pa., for 25 years and resigned as office manager of the New York office to accept the new position with the Alumni Association.

Franklin Institute Honors T. V. Buckwalter

THE George R. Henderson Medal of The Franklin Institute was presented to Tracy Vero Buckwalter, member A.S.M.E., formerly vice-president, Timken Roller Bearing Company, Canton, Ohio, on April 17, 1946, at the annual medal-day ceremonies of the Institute in Philadelphia, Pa. The medal was awarded to Mr. Buckwalter in consideration of his accomplishments in applying antifriction bearings to railroad locomotives and cars, thus contributing to the increase in reliability and decrease in maintenance costs of modern railroad equipment.

As vice-president of the Timken Roller Bearing Company since 1922, Mr. Buckwalter not only furnished engineering leadership but contributed personally to the technique of application and the details of design of roller bearings. In 1928 he convinced his company of the desirability of building a complete experimental locomotive in which all of the roller-bearing applications he had conceived to that date were included. Originally serving as a road research laboratory, this locomotive was later sold, and is at present operating in regular service.

State-Wide Convocation of Engineers to Be Held in New Haven, Conn.

THE function of The American Society of Mechanical Engineers as a catalyst in American industry, entering into and assisting engineering enterprise, while impartially bestowing professional guidance to individual engineers, will be the theme of a state-wide convocation of Connecticut engineers. The convocation, sponsored by the New Haven Section of the A.S.M.E., will be held at the New Haven Lawn Club, New Haven, Conn., May 25, 1946.

For fifteen years members of the A.S.M.E. in Connecticut have been meeting annually, with members of other societies and leaders of industry as their guests, for the purpose of cultivating the co-operation of Connecticut industry in the work of the Society.

Program

The afternoon program of the meeting will include a tour of Yale University, during which visits will be made to the art school, new gymnasium, Peabody Museum, New Haven Historical Museum, and the Mason Mechanical Engineering Laboratory. The New Haven Country Club golf course and the course of the Yale Club will be available to the guests who prefer a game of golf. Inspection trips to some of the industrial plants in the vicinity of New Haven are also planned.

A.S.M.E. Secretary to Speak

During the evening dinner meeting, the main event of the Convocation, C. E. Davies, secretary, A.S.M.E., will address members and guests on "Whither Mechanical Engineers." William M. Sheehan, chairman, A.S.M.E. Membership Development Committee, will speak on "Why People Should Join the A.S.M.E." Alton C. Chick, vice-president, A.S.M.E. Region I, will participate in the program, and it is expected that D. Robert Yarnall, president, A.S.M.E., will be present.

R.P.I. to Expand Enrollment

RENSSELAER POLYTECHNIC INSTITUTE of Troy, N. Y., plans to expand its enrollment by more than 100 per cent as a temporary emergency measure for the education of veterans and relief of "the critical shortage" of scientists and engineers, Dr. Livingston W. Houston, president R.P.I., told alumni at their annual midyear meeting held in New York, N. Y., March 9, 1946.

Formally inaugurated during the meeting as the eleventh president of the nation's oldest college of science and engineering, President Houston disclosed that R.P.I. had also decided to undertake a long-term program of permanent expansion in buildings and equipment, which would cost more than $4,000,000, to prepare "for what we believe will be a permanent growth in engineering education."

A.S.A. Honored by Navy

THE Certificate of Achievement of the U. S. Navy was presented to the American Standards Association "in recognition of the specialized accomplishment on behalf of the United States Navy and of meritorious contribution to the national war effort."

The presentation was made in Washington, D. C., by John L. Sullivan, assistant secretary of the Navy. Henry B. Bryans, president, A.S.A., accepted the certificate in behalf of the 94 national groups that make up the American Standards Association.

The citation read: "This organization, upon whose Executive Board the Navy has representation, performed a commendable service to the Navy through the preparation and development of safety standards, codes, and specifications, many of which have been adopted by the Navy. This program of the American Standards Association speeded up the process of the development and preparation of such codes which otherwise would have involved considerable research, and most important, would have taken considerable time to prepare and develop, had the Navy undertaken such tasks without the aid, guidance, and assistance which the American Standards Association so ably rendered."

Northwestern University Builds Large Testing Machine

A NEW testing machine designed to compress, stretch, and twist steel and other structural materials with greater force than any other testing machine in the country, was completed in March, 1946, at the Technological Institute of Northwestern University, Evanston, Ill.

The 30-ton fatigue tester can alternately stretch and compress two separate specimens simultaneously 200 times a minute with a force of a quarter of a million pounds. The machine is 25 ft long and 9 ft high.

The machine was placed in immediate use in an investigation of riveted and bolted connections, one of the largest engineering research projects currently being sponsored by The Engineering Foundation, the American Society of Civil Engineers, and some 15 private companies. Out of this co-operative research program will come new information which will make possible more economical structural materials and structural designs such as skyscrapers, bridges, and railroad coaches.

A.S.M.E. Engineers Sponsor Public Discussion of Northern New Jersey Transportation Problem

APPLYING the engineering approach to a civic problem of their communities, the engineers of the New Jersey Division of the A.S.M.E. Metropolitan Section and the A.S.M.E. Plainfield Section invited four experts to participate in a public discussion at the Central High School, Newark, N. J., March 26, 1946, on the subject, "Northern New Jersey Transportation."

The problem was divided into four parts. From the standpoint of community planning, Harry W. Alexander, firm of Harland Bartholomew and Associates, city planners for Newark and East Orange, N. J., spoke on the topic "Needs and Opportunities in Transportation From the Standpoint of City Planning." From the viewpoint of a state highway official, Dr. Spencer Miller, Jr., commissioner, State Highway Department, Trenton, N. J., described "Highway Development in Northern New Jersey—Present and Proposed." Perry M. Shoemaker, general superintendent, Lackawanna Railroad New York, N. Y., as spokesman for the New Jersey railroads, covered the subject "The Lackawanna's Place in the Transportation Future of Northern New Jersey," and finally G. Donald, general manager in charge of sales, Public Service Coordinated Transport, Newark, N. J., spoke on "Bus and Street-Car Transportation in North Jersey."

While the remarks of the speakers were reflections on the problem of transportation in northern New Jersey, many of the ideas they introduced were basic and applicable to any congested area whose development, out-paced the construction of transportation facilities.

Describing the northern New Jersey area with its complex intermixture of industry, commerce, and residence as one of the most highly urbanized sections in the United States, Mr. Alexander said that there was no dearth of city planning in the Newark Metropolitan area but suggested that more than independent city planning was necessary to effect a co-ordinated system of transportation facilities.

Dr. Miller, speaking for the State Highway Department, emphasized the value of community planning by stating that through the work of the local planning boards state highway engineers obtain the true picture of local needs so necessary for effective highway co-ordination.

Mr. Shoemaker reviewed the history of the Lackawanna Railroad and the part his company played in the development of New Jersey. He said that his company was not afraid of competition from other means of transportation but objected strenuously to taxation, part of which was used to maintain the facilities of the company's competitors.

As a means of expediting bus traffic, Mr. Murray suggested that parking be eliminated on main streets in cities during rush hours or at least restricting the parking to one side of the street. He said that such a measure would increase street space by fifty per cent without expense to a city administration.

Research Corporation Announces Recipients of Grants-in-Aid

THE Research Corporation through its president, Joseph W. Barker, has announced the initial list of Frederick Gardner Cottrell Special Grants-in-Aid of Postwar Research totaling nearly $175,000 for the first year of work. Other applications for grants are being investigated by the Advisory Committee composed of Dr. W. D. Coolidge of General Electric Company Laboratories; Dr. Thomas N. Chilton of duPont; Dr. Lloyd P. Smith, formerly of R.C.A. Laboratories and now of Cornell University; Mr. Timothy E. Shea of Western Electric Company; Colonel Staffer Warren of the Medical School, University of Rochester; Dr. R. R. Williams; and Dr. J. W. Barker of Research Corporation. Additional grants for the first year of work will be announced by the Corporation upon recommendation of the Advisory Committee. Only in exceptional cases are initial grants for more than one year. The Corporation is interested in receiving high-quality applications for grants from engineering and the smaller liberal-arts colleges.

List of Grants-in-Aid

In discussing these Frederick Gardner Cottrell Special Grants-in-Aid of Postwar Research, Dr. Barker said, "Research and teaching in our American educational institutions are facing a crisis today. The general pattern of research in our colleges and universities was seriously disrupted by the war. Talented members of the faculties were drafted into war research or war service. In plentiful measure they proved their worth and the value to our country of their educational and scientific backgrounds.

"But now the question is whether these men can be brought back to the college laboratories and classrooms where there is great necessity for them if we are to re-establish adequate research closely associated with inspired teaching. The flood of students including the discharged veterans is imposing a most severe strain on our faculties to provide adequate teaching staffs and unless proper steps are taken to assist research projects and research workers the pressures for teaching may hinder the re-establishment of adequate fundamental research.

"Research Corporation's Board of Directors recognized this problem and in the fall of 1945 announced the establishment of the Frederick Gardner Cottrell Special Grants-in-Aid of postwar research with an initial fund of $2,500,000 to be expended over a five-year period.

"It was felt that such a program of aid to fundamental research in the pure and applied sciences would be of great value at this time when wartime research men are considering whether to return to educational institutions or to accept industrial positions."

The initial Frederick Gardner Cottrell Special Grants-in-Aid for Postwar Research were made to the following institutions.

Amherst College; project, Design and Construction of Equipment for Measuring Faint Stars by the Photoelectric Method; director, Dr. John S. Hall.

Boston University; project, An Experimental Examination of the Properties of the Solvated Electron by Calorimetric, Density, and Viscosity Studies of the Alkali-Metal Liquid-Ammonia Systems; director; Prof. Lowell V. Coulter.

University of California; project, The Correlation of Photochemical Processes with Molecular Absorption Spectra; director, Dr. F. E. Blacet.

Carnegie Institute of Technology; project, Properties of Matter at Extremely Low Temperatures, and Super Conductivity—Especially of Thin Films; director, Prof. Immanuel Estermann.

Catholic University; project, Chemical Reactions Between Gases and Solids; director, Dr. Walter John Moore, Jr.

Duke University; project, Microwave Absorption Spectra of Molecules; director, Dr. Walter Gordy.

Indiana University; project, A Study of Beta Disintegration Process; director, Dr. L. M. Langer.

Kansas State College; project, Study of Photoelectric and Thermionic Properties of Spectroscopically and Thoroughly Outgassed Nickel With Emphasis on Studies at the Curie Point; director, Dr. A. B. Cardwell.

Michigan State College; project, Ionization Produced in Gases by Electrons of Energies Less Than 2000 Electron Volts; director, Dr. Thomas H. Osgood.

University of Minnesota; project, Analysis of Electron and Ion Collision Phenomena in Gases and Vapor; director, Dr. John T. Tate.

University of Minnesota; project, Isotopes; director, Dr. A. O. C. Nier.

Muhlenberg College; project, The Measurement of the Velocities and Absorption Coefficients of Sound Waves in Gases, as a Function of Temperature and Pressure at Various Supersonic Frequencies; director, Dr. I. F. Zartman.

University of New Hampshire; project, A Study of Inorganic Fluorides; director, Dr. H. M. Haendler.

North Texas State Teachers College; project, Stereoisomerism of Synthetic and Natural Polyenes; director, Dr. R. B. Escue, Jr.

New York University; project, Investigation of Nuclear Disintegrations Produced by Cosmic Radiation; director, Dr. Serge A. Korff.

University of Notre Dame; projects, (*a*) Extension of Experiments on the Excitation of Nuclei by X Rays and Electrons by Observation of Shorter Metastable Lifetimes, (*b*) Extension of Experiments on the Excitation of Nuclei by X Rays and Electrons by Increasing Excitation Energy; directors, Dr. George B. Collins and Dr. Bernard Waldman.

Ohio State University; project, Infrared Spectra of a Large Number of Polyatomic Molecules Measured Automatically Under High Dispersion; director, Dr. H. H. Nielsen.

Oregon State College; project, Synthesis of Amino Alcohols Derived from Pyrimidines and Quinazolines; director, Prof. B. E. Christensen.

Pennsylvania State College; project, Influence of Range of Stress on the Fatigue Strength of Metals Subjected to Axial and Biaxial Stresses; director, Dr. John A. Sauer.

University of Pennsylvania; project, Nuclear Physics; director, Dr. G. P. Harnwell.

Queens College; project, Isotope Research; director, Dr. M. L. Eidinoff.

Rutgers University; project, Nuclear and Electronic Paramagnetism at Room and Low Temperatures; director, Dr. F. G. Dunnington.

Stanford University; project, Nuclear Induction and Its Application to Polarized Neutrons; director, Dr. Felix Bloch.

Stevens Institute of Technology; project, Absorption Spectra, Particularly in the Far Ultra-Violet, of Liquids to be Followed Later by Studies of Other Properties, etc.; director, Dr. E. G. Schneider.

Tuskegee Institute; project, The Methods of Preparation and the Chemical Properties of the Bis-Brominated Ethers; director, Dr. C. T. Mason.

Southwestern at Memphis; project, Vapor-Phase Catalytic Preparation of High-Molecular-Weight Ketones; director, Dr. J. L. A. Webb.

University of Tulsa; project, Distribution of Carbon Dioxide in Systems Containing Two Liquid Phases; director, Dr. F. T. Gardner.

State College of Washington; projects, (*a*) Enthalpy Changes at Unit Surfaces on Wetting of Solids by Liquids, (*b*) A Study of Significance of Variations in the Values of the Densities of Fine Powders as Measured in Various Liquid Media. (*c*) Development of New Techniques for the Study of Liquid Films at Solid-Liquid Interfaces; director, Prof. J. L. Culbertson.

University of Wyoming; project, Determination of Neutron Resonance Energies and Half-Life Periods of Induced Radio Activities; director, Dr. Emil J. Hellund.

Many other Institutions Aided

Research Corporation is a nonprofit organization devoted to advancing research and technology by use of revenues from patents assigned to it by interested inventors. The Corporation was begun in 1912 with the gift, through Dr. Frederick Gardner Cottrell, of patent rights on electrical precipitation, which is used for removing dust, fume, and mists from industrial gases. Over the intervening years the Corporation has served colleges and universities by the administration of patents arising from researches in their laboratories. From the proceeds of these and other patents it has aided in the past some 52 institutions by grants totaling over one and a quarter million dollars. It is continuing grants on the normal program as well as these Frederick Gardner Cottrell Special Grants. In addition, through the Williams-Waterman Fund, it is continuing to make grants for research in the combat of dietary diseases.

Dr. Barker who has been acting president of Research Corporation since January, 1945, has resigned as dean of engineering at Columbia University to become the full time president of Research Corporation to administer these grants programs as well as the other business activities of the Corporation.

Eighteenth A.S.M.E. Oil and Gas Power Conference to Be Held in Milwaukee, Wis., June 12 to 15, 1946

THE Eighteenth National Oil and Gas Power Conference sponsored by the Oil and Gas Power Division of The American Society of Mechanical Engineers will be held at Hotel Schroeder, Milwaukee, Wis., June 12 to 15, 1946. Because of the government ban on traveling no conference was held in 1945. As a result of plans for the two years of preparation, the 1946 conference promises a program of technical sessions packed with interest.

There will be a total of seven technical sessions. Except for an afternoon session on Wednesday June 12, 1946, sessions will be scheduled during the mornings and evenings so that the afternoons will be free for inspection trips to the laboratories and shops of the Allis-Chalmers Manufacturing Company, the Diesel shops of the Norberg Manufacturing Company, and the works of the Falk Corporation. A banquet will be held on Wednesday evening and a social event is planned for Thursday evening.

Gas Turbines and Diesel Engines

Of timely interest will be two symposiums, one on new railroad Diesel engines and the other on the recently developed gas Diesel engines. Short papers will be presented by engineers who have made definite contributions to activity in these fields.

Considerable interest is expected to center on the two sessions on gas turbines. The first session will include a report of extensive experience with open-cycle units and engineers attending the second session will hear reports on European developments by members of the Gas-Turbine Co-Ordinating Committee, who have lately returned to this country. A paper on governing of closed-cycle machines will also be presented at this session.

D.E.M.A. to Participate

The Diesel Engine Manufacturers' Association will participate in the events scheduled for the first day of the conference. The banquet program will be sponsored by the D.E.M.A. It will include brief talks by members of the executive board of the Association on the future of Diesel engines in the field of utilities, ships and boats, railroads, the oil industry, and the automobile. E. J. Schwanhausser, president, D.E.M.A., will introduce the speakers and summarize their remarks.

Exhibits

Engineers attending the conference will have the opportunity to inspect the latest products of engine and accessory manufacturers at an exhibit made possible by the co-operation of approximately 50 manufacturers. The exhibit this year will be the largest ever held in connection with the National Oil and Gas Power Conference. It is hoped that jet-propulsion engines of some of the American builders and a group of captured German jet-propulsion engines will be on exhibit.

Committee

Plans for the conference are in charge of the following: H. E. Wetzel, chairman, A.S.M.E. Milwaukee Section; Robert Cramer, chairman, Conference Committee, Milwaukee Section; Bruno V. E. Nordberg, honorary chairman of the conference; R. Tom Sawyer, chairman, Meetings and Program Committee, A.S.M.E. Oil and Gas Power Division; and E. J. Kates, chairman, A.S.M.E. Oil and Gas Power Division.

The preliminary program follows:

WEDNESDAY, JUNE 12

Noon

Luncheon

History of the Diesel-Electric Locomotive, by L. G. Coleman, Baumis-Warford Company, Townsend, Mass.

Afternoon

History of the Diesel Industry and the Diesel Engine Manufacturers Association, by Robert B. Rice, director of the Diesel school of North Carolina State College, Raleigh, N. C.

Supercharging and Internal Cooling Cycle for High Output, by Ralph Miller, Nordberg Manufacturing Company, Milwaukee, Wis.

Evening

Banquet

Welcome, by Edgar J. Kates, chairman, A.S.M.E. Oil and Gas Power Division, consulting engineer, New York, N. Y.

Toastmaster, E. J. Schwanhausser, president, D.E.M.A., Worthington Pump and Machinery Company, Harrison, N. J.

Speakers will be:

R. H. Morse, Jr., president, Fairbanks Morse and Company, on Utilities

R. E. Friend, Nordberg Manufacturing Com-

A.S.M.E. MILWAUKEE SECTION ORGANIZES COMMITTEES FOR THE EIGHTEENTH NATIONAL OIL AND GAS POWER CONFERENCE

(*Standing, left to right:* E. Grieshaber, M. Ruess, G. Haislmeier, F. W. Weithofer, W. D. O'Connor, R. Cramer, chairman, Milwaukee, Convention executive committee, S. Judd, T. A. Wetzel, chairman, A.S.M.E. Milwaukee Section, R. Fobian, E. Neubauer, J. Jorgenson, R. Meiners A. Hughes, A. Schmidt, J. Bunce, and G. Wolf; *seated left to right*, G. Miniberger, J. Brower, C. Malischke, W. Alexandroff, H. Heywood, secretary, A.S.M.E. Milwaukee Section, E. Huber, and Mr. Fisher.)

pany, Milwaukee, Wisconsin, on Ships and Boats
C. E. Brinley, The Baldwin Locomotive Works, Eddystone, Pa., on Railroads
A. W. McKinney, National Supply Company, Springfield, Ohio, on Oil in Industry

THURSDAY, JUNE 13

Morning

Railroad Diesel Symposium

Speakers will be:
J. H. Davids, Fairbanks Morse and Company, Chicago, Ill.
Ralph Boyer, Cooper-Bessemer Corporation, Mt. Vernon, Ohio
Ralph Miller, Nordberg Manufacturing Company, Milwaukee, Wis.
Hans Bohuslav, Sterling Engine Company, Buffalo, N. Y.
George Nolteen, National Supply Company, Springfield, Ohio

Afternoon

Inspection Trip

Laboratories and gas-turbine shops, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

FRIDAY, JUNE 14

Morning

Gas-Turbine Session

The Gas Turbine as a Land-Power Unit, by A. D. Hughes, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.
Metallurgical Consideration of Gas Turbines, by N. L. Mochel, Westinghouse Electric Corporation, Pittsburgh, Pa.
Gas-Turbine Patent Analysis, by E. M. Fernald, professor, Lafayette College, Easton, Pa.

Morning

Diesel-Engine Session

Diesel Combustion Temperatures—The Influence of Operating Variables, by O. A. Wyehara, P. S. Myers, K. M. Watson, and L. A. Wilson, University of Wisconsin, Madison, Wis.
Diesel Engines for Peak Loads and Stand-By Service, by A. C. Kirkwood, firm of Burns and McDonnell, Kansas City, Mo.

Afternoon

Inspection Trip

Plant of Nordberg Manufacturing Company, Milwaukee, Wis.

Evening

Gas-Diesel Symposium

Speakers:
Emil Grieshaber, Nordberg Manufacturing Company, Milwaukee, Wis.
Ralph Miller, Nordberg Manufacturing Company, Milwaukee, Wis.
Ralph Boyer, Cooper-Bessemer Corporation, Mt. Vernon, Ohio
C. E. Cox, Chicago Pneumatic Tool Company, New York, N. Y.
J. C. Barnaby, Worthington Pump and Machinery Corporation, New York, N. Y.

SATURDAY, JUNE 15

Morning

Gas-Turbine Session

Gas-Turbine European Developments, by S. A. Tucker, McGraw Hill Publishing Company, Limited, London, England
Regulation Problems of Closed-Cycle Gas Turbines, by F. Salzmann, Escher Wyss, Zurich, Switzerland

Morning

Marine Session

The Bowes Drive, by B. C. Seaman, The Elliott Company, Ridgeway, Pa.
Chain Transmission for Marine Propulsion Service, by Norman Bremer, Morse Chain Company, Ithaca, N. Y.

A.S.M.E. Textile Lubricants Committee Meets in Boston Mass., March 15, 1946

A STANDARD for identifying lubricants used in the textile industry is one step nearer realization as a result of a meeting sponsored by the Textile Lubrication Committee of the A.S.M.E. Textile Division held in the Manger Hotel, Boston, Mass., March 15, 1946. A committee of six engineers, representing some of the major oil companies of the country, was chosen to draw up a preliminary standard for discussion at the next meeting of the Textile Lubrication Committee scheduled for June, 1946.

Following a brief talk by Carl Brown, chairman, A.S.M.E. Textile Division, on the general purpose of the meeting, A. E. Winslow, chief engineer, Farrel-Birmingham Company, Stonington, Conn., read a prepared talk emphasizing the need for and the advantages of a standard for identifying lubricants used in the textile industry.

The discussion that followed Mr. Winslow's paper indicated that there was general agreement among the 36 representatives of textile-machinery manufacturers and oil companies, who attended the meeting, on the following points: (1) A standard would be of definite value; (2) the drafting of a suitable standard would require considerable work; (3) representatives of oil companies are best qualified for such a task.

The following subcommittee was chosen to work up a preliminary draft for discussion at the June, 1946, meeting of the Textile Lubrication Committee: R. J. Bender, oil engineer, Sinclair Oil Company; A. F. Brewer, oil engineer, The Texas Company; R. W. Flynn, oil engineer, Gulf Oil Corporation; G. J. Van Liew, assistant chief engineer, Socony-Vacuum Oil Company; J. B. Tuttle, assistant manager, engineering division, Standard Oil Company of New Jersey; and F. L. Thomason, southern district manager, New York and New Jersey Lubricant Company.

Harry A. Winne Co-Author of Report on World Atomic-Energy Development

HARRY A. WINNE, member A.S.M.E., vice-president in charge of engineering, General Electric Company, Schenectady, N. Y., as member of the board of consultants appointed by the State Department's Committee on Atomic Energy in January, 1946, to analyze the question of international control of nuclear energy, is co-author of the history-making report released by the State Department on March 29, 1946.

The report proposes a world-wide Atomic Development Authority to control all phases of ownership and development of nuclear energy. It calls for possession by the Authority of all uranium deposits in the United States and elsewhere in the world and the ownership of all present and future nuclear-fission plants. According to the report, such an Authority would be managed by an international body of scientists and engineers whose prime loyalty would transcend national affinities.

Intended as a proposal for discussion by the atomic-energy committee of the United Nations, the board's recommendations show how atomic energy for military uses can be con-

E.I.C. MEDAL AWARDED TO GEORGE A. WALKEM, MEMBER A.S.M.E.

(In recognition of his achievement in the development of Canada, The Engineering Institute of Canada awarded The Julian C. Smith Memorial Medal for 1945 to George Alexander Walkem, member A.S.M.E., managing director, Vancouver Machinery Depot, Limited, Vancouver, British Columbia.)

trolled without restricting seriously research scientists and engineers who aim at the development of nuclear energy for industry.

Other members of the board were: David E. Lilienthal, chairman, Tennessee Valley Authority; Chester I. Barnard, president, New Jersey Bell Telephone Company; Dr. J. Robert Oppenheimer, California Institute of Technology and University of California; Dr. Charles Allen Thomas, vice-president, Monsanto Chemical Company.

Applied Mechanics Division to Meet in Buffalo, N. Y. June 21–22, 1946

THE Applied Mechanics Division will hold its semiannual meeting in Buffalo, N. Y., as guest of the A.S.M.E. Buffalo Section at the Hotel Sheraton on Friday and Saturday, June 21 and 22, 1946.

Tentative plans for this meeting call for three sessions as follows: June 21, morning, Strength of Materials; June 21, afternoon, Theory of Metals; June 22, morning, Fluid Mechanics.

Since hotel reservations are not plentiful, Howard W. Emmons, secretary, Applied Mechanics Division, suggests that members who plan to stay over in Buffalo during the meeting make their reservations early. He said that there are a limited number of rooms available at Hotel Sheraton.

The spring meeting of the Society of Experimental Stress Analysis will be held at Hotel Statler, Buffalo, N. Y., June 24 to 26, 1946. Some A.S.M.E. members may plan to stay over for this event.

The tentative A.S.M.E. program follows:

FRIDAY, JUNE 21

Morning

Strength of Materials Session

Buckling Under Locally Hydrostatic Pressure, by G. H. Handelman, department of applied mathematics, Brown University, Providence, R. I.

Initially Curved Flat Spring With Large Deflections, by F. Hymans, Otis Elevator Company, New York, N. Y.

An Elementary Theory of the Bourdon Gage, by Alfred Wolf, Geophysical Research Corporation, Tulsa, Okla.

Afternoon

Theory of Metals Session

Proposed Experiments for Further Study of the Mechanism of Plastic Deformation, by J. S. Koehler, professor, department of physics, Carnegie Institute of Technology, Pittsburgh, Pa.

General Properties of Solid Solutions of Metals, by R. Smoluchowski, research laboratory, General Electric Company, Schenectady, N. Y.

Thermodynamic Theory of Fracture of Metals, by Edward Saibel, professor, Carnegie Institute of Technology, Pittsburgh, Pa.

Strain and Failure, by M. Gensamer, Pennsylvania State College, State College, Pa.

SATURDAY, JUNE 22

Morning

Fluid Mechanics Session

The Steady Turbulent-Flow Equations of Continuity, Momentum, and Energy for Finite Systems, by E. R. Van Driest, assistant professor of mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass.

Boundary-Layer Effects in Transonic Flow, by Hans Liepmann, assistant professor of aeronautical engineering, Guggenheim Aeronautical Laboratory, California Institute of Technology, Pasadena, Calif.

Supersonic Nozzle Design for the Engineer, by A. E. Huckett, instructor, Guggenheim Aeronautical Laboratory, California Institute of Technology, Pasadena, Calif.

(Two other papers have been requested)

Afternoon

Elasticity and Plasticity Session

A Photoelectric Method of Measuring Damping in Metal Forks at Elevated Temperatures, by T. E. Pochasky, Battelle Memorial Institute, Columbus, Ohio.

Internal Friction in Engineering Materials, by J. M. Robertson, assistant professor of engineering mechanics, Pennsylvania State College, State College, Pa., and A. J. Yorgiadis, research engineer, Sonntag Scientific Corporation, Greenwich, Conn.

Analytical Expressions for Principal Strains, by W. T. Thomson, associate professor of mechanics, University of Wisconsin, Madison, Wis.

Navy Honors Battelle Memorial Institute

THE Navy Ordnance Development Award has been presented to the Battelle Memorial Institute, Columbus, Ohio, by the Bureau of Ordnance, U. S. Navy, in recognition of the Institute's contributions to the development of welded net panels for submarine torpedo nets. This is the fifth award conferred on the Institute for its war service.

Some forty members of the Battelle staff also received individual awards from the Bureau of Ordnance for the special parts they played in the prosecution of naval ordnance research.

Sections

"Precision Measurements" Talk at Anthracite-Lehigh Valley Section

At the meeting on Feb. 22 at Lehigh University, Bethlehem, Pa., Lieut. Col. Wm. J. Darmody, Philadelphia Ordnance District, U.S.A., spoke on "Precision Measurements." Colonel Darmody outlined the history of precision measurements in industrial mass production, and with slides showed instruments used. He explained the services of Ordnance District gage laboratories to industry in dimensional control of products. The 55 members and guests were then conducted through the Philadelphia Ordnance District gage laboratory which has been presented to Lehigh University, and were permitted to examine and operate the instruments.

On March 22 at the Berwick Golf Club, Berwick, Pa., H. S. Swan, general welding supervisor, American Locomotive Company, gave a talk on "The Welding of Modern Steam and Diesel Locomotives." With the aid of about 90 slides, the speaker gave in detail the use made of welding in building with both steam and Diesel locomotives. He told of the procedure followed with machine-welding of boiler drums and tenders, and the personnel setup and method of paying piecemeal. A very lively discussion followed. Forty-eight were present.

"Jet-Propulsion Comparisons" Subject at Boston Section

The meeting on March 14 at Northeastern University, Boston, Mass., presented a talk "Jet-Propulsion Comparisons," by Dr. J. C. Hunsaker, honorary member A.S.M.E., head of the department of mechanical engineering, Massachusetts Institute of Technology. Dr. Hunsaker described briefly the basic types of jet-propulsion devices for aircraft-engine propeller, turbo propeller, intermittent ram jet, ram jet and rocket. These were illustrated by slides. He then discussed their basic limitations due to the present state of the art, and to the inherent difficulties of the type. The talk was concluded with a graphic presentation of the performances of the more useful types. One hundred and seventy-five were in the audience.

Bridgeport Section Greets Dr. Lillian Gilbreth with Enthusiasm

On March 7 at the Hotel Barnum, Bridgeport, Conn., Dr. Lillian Gilbreth, member A.S.M.E., president, Gilbreth, Inc., Montclair, N. J., spoke before an audience of over 200 on "Accomplishments of Work Simplification (World War II)." Her talk covered many factors in management of employees, employee aptitude, industry, and success. She paid tribute to the employer for his human attributes. Dr. Gilbreth handled her subject in a masterly manner and held the interest of those present intently.

Central Illinois Section Has Talk on Air Conditioning

On March 14 at the University Club, Peoria, Ill., L. G. Huggins, manager, air-conditioning

and refrigeration department, B. F. Sturtevant Company, spoke on "Air Conditioning and Reverse Cycle Heating." Mr. Huggins predicted a bright future for air conditioning, with heavy application in homes and small businesses. He said that new horizons are appearing in the air-conditioning field. The economical, noiseless operation of equipment is considered to be a factor that will help sell the idea. Seventy were present.

Central Indiana Section Has Varied Programs

At the meeting on Feb. 8 in the Antler's Hotel, Indianapolis, Ind., Carl G. Schmid spoke on the subject "Manufacture Tolerances Required in Manufacture of Norden Bombsight." Mr. Schmid traced the development of the Norden bombsight and described the methods used to maintain the unheard-of tolerances required to produce this instrument. He said that the use of unskilled workers to manufacture the bombsight on a mass-production basis produced problems, the solution of which are the marvel of the engineering profession.

On March 8 at the Antler's Hotel, Thomas S. McEwan, vice-president, A.S.M.E., Region VI, was the speaker. In discussing his subject "Streamlining Management," Mr. Mc Ewan said that industry has been challenged by present-day changes and readjustment, and that streamlining an enterprise for action signifies organizing, co-ordinating, guiding, and controlling all of the activities of a business. Forty-five were present.

Servomechanisms Discussed at Chicago Section

On March 21 at the Stevens Hotel, Chicago, Ill., J. P. Smith, engineering division, General Electric Company, spoke on "Servomechanisms as an Engineering Tool." The meeting was under the sponsorship of the Production Engineering and Materials Handling Division of the Section. Mr. Smith first gave an explanation of what a servomechanism is. Basically, he said, it is the amplification of a force in a definite directed distance so as to accomplish a major item of work. Such mechanism can be mechanical, such as the windless and old-time ships' steering mechanism, but at the present time electric and hydraulic mechanisms serve as the best transmitting mediums. Slides were shown illustrating these various types of fundamental mechanisms, and a sound film illustrated the control of fire power on a B-29 plane. The discussion which followed brought out the various differences between the hydraulic and electric servomechanisms. Their particular uses and adaptability were discussed, as applied in the recent war.

Cincinnati Section Attends Council Meeting

On March 1 at the 11th Annual Joint Meeting of the Technical and Scientific Societies Council of Cincinnati, held in the Wilson Auditorium, University of Cincinnati, Cincinnati, Ohio, the speaker was Dr. Arthur H. Compton, chancellor, Washington University, St. Louis, Mo., who addressed the audience on "Science Shapes the Future." Dr. Compton, who is a Nobel Prize winner, said that scientific and technological progress has imposed three major trends upon the world: (1) The trend toward increasing education and specialized training; (2) the trend toward improved co-operation and co-ordination of effort between individuals and groups; (3) the trend toward finding and establishing common objectives for which we should strive. Elaborating on each, he emphasized the third as the greatest of all the factors that make possible the co-operation so necessary to a strong modern society. He said that we find life has meaning only when there is an objective we consider worth working for, and illustrated his point by citing the example of World War II when victory became the goal of all. Over 1200 were in the audience. Among the guests of honor was the mayor of Cincinnati, James G. Stewart.

"Automatic Transmissions" Subject at Cleveland Section

"Automatic Transmissions" a talk by Renken Brunken, was the feature of the meeting on March 14 at Cleveland, Ohio. The lecture, which was illustrated, covered the subject of the hydraulic transmissions which are now being applied to gasoline buses. There were 80 in the audience.

V. E. Parry, U. S. Bureau of Mines, at Colorado Section

At the March 8 meeting in the Oxford Hotel, Denver, Colo., V. E. Parry of the U. S. Bureau of Mines, spoke on "Conversion of Low-Rank Western Fuels Into Improved Forms of Energy." In his talk Mr. Parry dealt with the process of steam-drying lignite. He explained the operation of the pilot plants installed at Golden, Colo., and at Grand Forks, N. D., where 310 Btu cu ft water-gas is produced from lignite and subbituminous coals. A discussion period followed.

Dr. Lillian M. Gilbreth Speaks at Dayton Section

On March 11 at the Engineers' Club, Dayton, Ohio, Dr. Lillian M. Gilbreth, member A.S.M.E., president, Gilbreth, Inc., Montclair, N. J., spoke on "Our Part in Solving Today's Management Problems." She touched briefly on many of management's problems during the war period, and remarked that postwar problems are the re-establishment of old disciplines, and the establishment of goodwill as a basis for development of the principles of scientific management.

Two hundred and fifty members and guests were very much impressed by Dr. Gilbreth's command of her subject.

Col. Walker Cisler Heard at Detroit Section

On March 5, in the Rackham Building, Detroit, Mich., an interesting talk entitled "Rehabilitation of Europe's Power System" was given by Col. Walker Cisler of the Detroit Edison Company. Colonel Cisler explained the problems involved in re-establishing Europe's utility systems. Slides were shown of damaged power plants and the complete arrangement of the power system. S. R. Beitler, regional vice-president, A.S.M.E., Region V, was present and presented George Willcox with a 50-year-membership medal.

Ithaca Section Has Two Joint Meetings With Cornell Student Branch

On March 15 at Olin Hall, Cornell University, Ithaca, N. Y., a joint meeting with the Cornell student branch was held. F. E. Dart, a graduate student, formerly with the U. S. Rubber Company, spoke on "Manufacture and Performance of Rubber Tires." He explained how tires are built, the advantages of methods used, how difficulties are overcome, and emphasized the need for experimental work as a basis for future improvement in tire performance. The audience totaled 42.

Another joint meeting was held with the student branch in Room 2, West Sibley, Cornell University, when H. B. Osborn, Jr., of the Ohio Crankshaft Company, gave a talk entitled "Induction Heating." Mr. Osborn explained the advantages of each of the three methods of producing high-frequency current for inductive heating. He used slides to illustrate the applications, with emphasis on the resulting low cost and high production. Fifty-three were in the audience.

Dr. Lillian M. Gilbreth at Hartford Section

On March 5 a dinner meeting was held by the A.S.M.E. Hartford Section, Hartford, Conn. The speaker was Dr. Lillian M. Gilbreth, member A.S.M.E., president, Gilbreth, Inc., Montclair, N. J., who talked on "Our Part in Solving Today's Management Problems." The audience of 75 enjoyed Dr. Gilbreth's discussion of the subject.

Kansas City Section Welcomes A.S.M.E. Member as Speaker

Everett S. Lee, member A.S.M.E., general engineering laboratory, General Electric Company Schenectady, N. Y., was the speaker on March 11 at the University Club, Kansas City, Mo. In his talk entitled "What Is New in Science and Engineering," Mr. Lee explained the part the war played in developing unusual instruments for special purposes, and said that the same instruments, with minor changes, are now being used for peace-

time purposes. Slides of new measuring instruments were shown and Mr. Lee gave the story of each one.

Dr. Lionel S. Marks Speaks to Memphis Societies

Dr. Lionel S. Marks, Fellow A.S.M.E., professor emeritus of mechanical engineering, Harvard University, Cambridge, Mass., was the guest of honor at a dinner at the University Club, Memphis, Tenn., on March 6, at which he was the featured speaker. The meeting was held in Goodwyn Institute under the auspices of the Section, the Memphis Technical Societies Council, and the Goodwyn Institute. In his talk entitled "Jet Propulsion and Rockets," Dr. Marks said that while there is good reason for the use of high flying speeds for military purposes it is very questionable whether they will prove to be economically justifiable in commercial uses. He explained the terms, subsonic and supersonic in air speeds, and stated that in order to get the necessary power for high speed it becomes necessary to use the gas turbine and jet propulsion, but since the jet-plane efficiency is about one half of the propeller-plane efficiency, this would double fuel consumption; and that therefore it appears very doubtful whether transportation in peacetime will be economical at speeds exceeding 400 to 450 miles an hour. Dr. Marks also explained the nature of the robot, or V-1 of Germany which, he said, "has an efficiency of between 2 and 3 per cent, or about one fourth that of a propeller plane. Obviously such a device would be of no use in peacetime." He added that the fundamental disadvantage of the rocket is the weight of propellant it must carry for a given liberation of energy. The audience numbered 700.

Mid-Continent Section Has Record Meeting

On Feb. 25 in Tulsa, Okla., Dr. Lionel S. Marks, Fellow A.S.M.E., professor emeritus, Harvard University, addressed a record meeting of over 400 engineers on the subject "Recent Developments in Jet Propulsion and Rockets." Dr. Marks covered his subject very thoroughly in an interesting and entertaining manner. One surprising point he made was that jet propulsion would probably never be used on commercial aircraft since it is very inefficient at low speeds—under 400 or 500 miles per hour—and the horsepower required to attain a given thrust increases tremendously as speed is increased, say from 300 to 600 miles per hour. Economic considerations, he said, will prohibit high speeds except for military aircraft.

Milwaukee Section Hears Talk by Dr. H. T. Heald

On March 9 at the Plankinton Hotel, Milwaukee, Wis., Dr. H. T. Heald, member A.S.M.E., president, Illinois Institute of Technology, Chicago, Ill., gave a talk on "Engineering Education Looks to the Future." He said that in reality the war showed us a great many errors in our speed-up of engineering education, and that the future direction seemed to be a return to the fundamentals of acquiring a good scientific foundation in principles, coupled with some knowledge of humanistics, and to the development of character and poise.

Dr. Heald felt that specialization will return to postgraduate work but that it will probably be connected more directly to industry in the future.

F. A. Ramsdell Speaker at New Haven Section

On March 13 at Ceriani's Cafe Mellone, New Haven, Conn., F. A. Ramsdell gave a talk on "Three-Dimensional Photography." He showed a series of slides, explained the procedure used in making the pictures, and described how the various effects were obtained. Forty members and guests were present.

"Antifriction Bearings" Topic at New London Section

On March 21 at the Mohican Hotel, New London, Conn., Frank U. Naughton, Jr., of the Hyatt bearings division, General Motors Corporation, spoke on "Antifriction Bearings." Mr. Naughton said that the earliest application of roller bearings in elementary form was the use of rollers under large weights by the Egyptian pyramid builders. A bronze ball bearing was found on the pleasure yacht of the emperor Nero, dating back 1900 years. The earliest American application of ball bearings was the mounting of a 400-lb weathervane on bronze ball bearings on a church in Lancaster, Pa., in 1792. He then traced the development of the antifriction bearing, which, he said, is dependent on advances in metallurgy for advances in bearing design. A series of slides were shown, demonstrating the various methods of application and mounting of bearings. Technical data leading to the selection of bearings was also discussed. There were 45 in the audience.

Ontario Section Has Joint Meeting With Engineering Institute of Canada

A joint meeting with The Engineering Institute of Canada was held on March 14 at Hart House, University of Toronto, Toronto, Can. Following dinner, Winnett Boyd, chief of engine-design section, Turbo Research Limited, Leaside, Ont., addressed the audience on the subject of "Aircraft Gas Turbines." Mr. Boyd discussed and illustrated a number of British, American, and German gas turbines of both the simple jet-propulsion type and the more recent type designed to drive airscrews. A number of slides were shown illustrating these engines as well as the airplanes in which they are used. The speaker also covered the simple thermodynamic theory connected with aircraft gas turbines, outlined the basic quantities that have to be taken into consideration in designing a gas-turbine engine, and showed several general-arrangement cross-sectional drawings of current jet-propulsion engines. The audience numbered 175.

Three Important Meetings at Philadelphia Section

At the regular monthly meeting on March 26 the program consisted of talks by two speakers. Capt. Logan McKee of the United States Navy gave a talk on "Manufacture, Storage, and Use of Hydrogen Peroxide by the Germans During the War." He said that a major use was for fuel in the propulsion of submarines and rocket bombs where hydrogen peroxide has the particular advantage of requiring no external supply of oxygen. Concentrations of 80 per cent and above are required for such service. Dr. D. B. Keyes, vice-president of the Heyden Chemical Corporation, was the second speaker. He discussed "Technical Industrial Intelligence in Germany." Because of the extent and diversity of the field to be covered, he said, and due to difficulties in securing personnel of the proper training to cover it, considerable delay has resulted in putting the information into available and useful form. Dr. Keyes then outlined the history of this project and made practical suggestions helpful to engineers interested in obtaining data on specific projects. D. Robert Yarnall, president A.S.M.E., and A. R. Stevenson, Jr., vice-president, A.S.M.E. Region III, were present. Dr. Stevenson presented a certificate of merit to Frank W. Miller, past-chairman of the Philadelphia Section, in recognition of his services to the engineering profession.

On March 5 the fourth of a series of special professional division meetings was held at the University of Pennsylvania under the sponsorship of the Industrial Instruments and Regulators Division. A paper on "Instrumentation in Plant Design" was presented by F. H. Trapnell of E. I. du Pont de Nemours and Company. The author discussed the methods of process layout intended to facilitate the application of instrumentation and automatic control.

Another of the special meetings was held on March 19. This was devoted to the Textile Division. Henry Crewdson of the American Viscose Company, spoke on "Rayon From Its Inception to the Present" and outlined the development of the rayon industry from first attempts to make artificial silk in 1734, up to the present world production in excess of a billion pounds a year. Rene Bovet, of the same company, discussed "Rayon in the Textile Field," explaining the manufacture of continuous-filament versus spun-rayon yarns and the weaving of various rayon fabrics.

"Fluid Catalytic Cracking" at Plainfield Section

At the March 20 meeting in the Elks' Club, Elizabeth, N. J., the speaker was O. L. White, mechanical engineer, Esso engineering department, Standard Oil Development Com-

pany, who spoke on "Fluid Catalytic Cracking." The lecture, illustrated with slides, described the fluid process of catalytic cracking for the production of high-octane motor and aviation gasoline, and closed with a discussion of the mechanical problems and features involved in the design and construction of the units. Slides were shown and a demonstration model also displayed. Seventy-five were present.

Providence Section Has Varied Programs

On March 5 at the Providence Engineering Building, Providence, R. I., two speakers were featured. The first, L. C. Grimshaw, spoke on "Heat and Deep-Freeze Treatment of Steel." He gave examples of tool and dies and the practical procedures for heat and deep-freeze treatments, illustrating with slides. The second speaker, Carl Himmelright, discussed the roto-finishing of airplane parts, after grinding to burr and break edges of intricate surfaces, by tumbling with crushed granite rock, 1/8 to 1 1/2-in. screened. He said that this was a remarkable solution of a difficult task.

The meeting on April 2 dealt with "Some Engineering Features of the Atomic Bomb Plants." The speakers were A. C. Klein and R. R. Wisner. They discussed the scope of the atomic-bomb project, the contributions of the engineering profession, the principles of the electromagnetic process, some problems encountered and overcome in the project's construction, and, finally, the electrical-engineering aspects of the project. Sixty-four were in the audience.

Rock River Valley Section Hears F. G. Tatnall

At the meeting on March 13 F. G. Tatnall, manager of testing research, Baldwin Southwark Division of the Baldwin Locomotive Works, spoke on the subject of "Physical Testing—Present and Future." Mr. Tatnall covered the engineering aspects of experimental stress analysis and dynamic testing, new trends in physical testing, and a discussion of multiaxial strains, stress risers, structural design improvement and the application of electronics to recording, switching, telemetering, analyzing, and fatigue testing. The lecture was extremely interesting, particularly to designers and men engaged in mechanical experimental work, and the Section enthusiastically endorses the speaker for other A.S.M.E. Sections.

St. Joseph Valley Section Visits Band-Instrument Plant

A dinner meeting and plant inspection was the feature of the March 15 meeting. The members were guests of C. G. Conn, Limited, Elkhart, Ind., the world's largest manufacturers of band instruments. Dinner was served in the plant cafeteria, followed by a tour of the plant. A discussion on plant processes and presentation of new products was given by L. B. Greenleaf, member A.S.M.E., chief engineer; J. B. Newell, junior member A.S.M.E., and L. E. Waddington, junior member A.S.M.E., design engineers; B. L. Canfield, assistant chief engineer; E. L. Kant, director of research; and A. L. Weeg, chief chemist, also gave short talks and accompanied the guests. Seventy-six enjoyed the hospitality of C. G. Conn, Ltd.

West Virginia Section Has Talk on Centrifugal Pumps

The February 26 meeting at the Daniel Boone Hotel, Charleston, W. Va., featured "Centrifugal Pumps for Process Industries," a talk given by A. T. Nielsen of the Worthington Pump and Machinery Corporation. Mr. Nielsen prepared this talk especially for the Section and in it he reviewed the special requirements for pumps handling chemicals. The discussion following his lecture was so intense that it was with difficulty that the meeting was adjourned. The guest of honor was S. R. Beitler, regional vice-president, A.S.M.E., One hundred and sixty were in the audience.

At the meeting on March 26 at the Daniel Boone Hotel, Charleston, W. Va., W. T. Piper, Piper Aircraft Corporation, Lock Haven, Pa., spoke on "Light Planes and Airports." He explained the special characteristics of personal, flying as distinct from commercial flying. The audience, numbering 140 members and guests, especially enjoyed the picturesque anecdotes which Mr. Piper related in the course of his talk.

Dr. Lillian M. Gilbreth at Worcester Section

On March 4 at Putnam Thurston's restaurant, Worcester, Mass., Dr. Lillian M. Gilbreth, member A.S.M.E., president, Gilbreth, Inc., Montclair, N. J., spoke to an audience of 175 on "Our Part in Solving Management's Problems." In her talk Dr. Gilbreth spoke of women's place in industry, and the problem of the returning veteran. She said that the major problems of management are: Conservation and development of new ideas which came into being during the war (biomechanics being one instance), at the same time putting back into practice the necessary disciplines and controls that were dropped; finding adequate jobs for those who need them.

Student Branches

University of Alabama Branch

At the March 4 meeting in the Engineering Building, permanent officers were elected to replace the ones temporarily selected. Those elected were: George Homich, chairman, Earl Karm, vice-chairman; Bob Hazen, secretary; and Joe Glasscock, treasurer. They will remain in office until the first meeting of the fall quarter, in order to insure a reorganization at that time.

On March 25 George Homich, chairman, discussed the importance of increasing the membership and also stressed the co-operation needed in planning appropriate programs. Dave Crockett, student member, gave a talk on "Magnetism," explaining the ancient as well as the modern conception of what magnetism really is.

Case School of Applied Science

On March 14 the branch was the guest of the Cleveland Section A.S.M.E. at a dinner held at the Cleveland Engineering Society Building. Prof. S. R. Beitler, regional vice-president A.S.M.E. addressed the students on the benefit and need of the A.S.M.E. in our present-day world. Renke Brunken of the White Motor Company, Cleveland, Ohio, was the guest speaker and his subject was "The Hydro-Torque Drive."

College of the City of New York

At the meeting on March 7 Frank Kasike, a graduate of Notre Dame, and now employed with the Wright Aeronautical Corporation, discussed the aspects of "Flight Test Engineering." His presentation of the subject greatly interested the students who are unfamiliar with this purely experimental branch of engineering, and encouraged them to ask numerous questions.

"Carboloy," the wonder cutting tool of today, was the subject of the March 14 meeting. A. M. Thomson was the speaker, and gave one of the most interesting talks of the season, illustrating with slides shown by A. Carver who accompanied Mr. Thomson. The process of manufacture from the raw material to the finished shape was shown and explained. The history, application, economy, and novel uses of carboloys were discussed. One of the new fields is the application of cemented carbide to be used for plug and thread gages employed in mass-production inspection. The life of these gages is increased remarkably. Mr. Thomson quoted a statement from the War Department which illustrates the significance and important contribution of this cutting tool in winning the war. He said that the tool reduced production costs to 1/16 of what they had been under the old method of production.

Colorado A & M College Branch

On March 4 a meeting was held in the Mechanical Engineering Building. The program consisted of two movies, one on lubrication and oils from the Bureau of Mines, the other a short reel on engineering fields and their purposes. Fourteen members were present.

Cornell University Student Branch

Two joint meetings with the Ithaca Section were held in March. The first, on March 15,

DR. J. C. HUNSAKER ADDRESSING STUDENT BRANCH OF MASSACHUSETTS INSTITUTE OF TECHNOLOGY

featured F. E. Dart; the second, on March 22, had as the speaker H. B. Osborn. These meetings are more fully reported under the Ithaca Section.

University of Florida Branch

A meeting was held March 7 in Florida Union. Prof. R. A. Thompson, junior member A.S.M.E., head of the mechanical-engineering department, gave a talk on the achievements of the student branch. He told the members the courses of study that students may follow in the field of engineering. Hope was expressed that the University may have an aeronautical-engineering school by September of this year.

On March 28 old and new business was discussed. John David Carpenter was appointed chairman of the athletic committee formed for the purpose of winning the field meet. Members acting as delegates to the Chattanooga Spring Meeting were: Donald O. Gallantine, William A. Lefley, William P. Hall, William M. Horton and Harold W. Burney.

Iowa State College Branch

On Feb. 7 at 209 Engineering Hall, Prof. J. S. Dodds of the civil-engineering department, and chairman of the Iowa Engineers' License Board of Examiners, gave the members some very helpful information concerning the licensing of engineers. He said that the purposes of having a license were: (1) Self-satisfaction; (2) recognition in the engineering world, and that the three parts to examination were: (*a*) theory, (*b*) practical problems, (*c*) interview.

At the meeting on Feb. 28 election was held for two offices, those of secretary and vice-president. Floyd J. Stanek was elected secretary, and Richard Dove, vice-president. Steve Wright was chosen as junior representative to the engineering council and Max Munger as senior representative. Gerald Henriksen was elected head chairman of the A.S.M.E. Veishea Committee.

University of Maryland Branch

On March 13 in the Arts and Science Building, Prof. John I. Yellott, member A.S.M.E., director, Institute of Gas Technology, Chicago, Ill., gave an illustrated lecture entitled "Jet Propulsion and Gas Turbines." Prof. Yellott discussed the development of the gas turbine from its earliest stages through its use in high-speed jet-propelled aircraft. He explained the problems that have been encountered in the application of coal as a combustable material for the gas turbine, and traced the research work that has been done by his committee. He predicted that a coal-fired gas-turbine locomotive will be built and in operation in the next few years. There was a large attendance and a lengthy discussion period followed the talk. An informal dinner preceded the program.

Massachusetts Institute of Technology Branch

At the March 5 meeting in room 6-120, chairman Albert I. Brayman opened the spring-term membership drive. Dr. J. C. Hunsaker, honorary member A.S.M.E., head of the department of mechanical engineering Massachusetts Institute of Technology spoke on "Your Future in Mechanical Engineering." The theme of his talk centered on the place of the mechanical engineer in society and in his profession. Dr. Hunsaker stressed the point that one can be an engineer and still be outside the bounds of the class of professionals, while on the other hand one may acquire professional status through technical qualifications, experience in the field, and membership in a known and recognized professional society. After obtaining the rank of a professional, it is necessary, the speaker said, to adopt certain attitudes and maintain them, but it is also necessary to take an active part in one's professional society. He closed his talk with the remark that the age-old adage is still true, that the amount which one receives from a project is proportionate to the amount of energy one expends on it. The chairman then appointed the following to office: Jerry Russo, treasurer; Edgar Lee, Harold Raiken, John G. Farrow, and Bob Werner, membership committee; Fred Flowers and Don Flowers, social committee; Ban Ostrosky, Bernard Marrill and Narsink Morarji, educational committee. Prof. W. M. Murray, member A.S.M.E., faculty adviser to the branch, was then introduced, and gave the reasons why an engineer should join the A.S.M.E., and the benefits he himself had enjoyed as a member.

On March 20 the program was a talk on "Introduction to Gas Turbines" given by Prof. C. Richard Soderberg, member A.S.M.E. The speaker first gave the historical background of the various steps in the development of the gas turbine into its present form. Starting with the steam engine, he reviewed the hot-air engine, and in conclusion discussed the modern turbine. Chairman A. I. Brayman thanked the members for increasing the membership to over the 100-goal.

University of Michigan Branch

On Feb. 6 in Michigan Union the speaker was Fred Miller, personnel director of the Ford Motor Company. Mr. Miller, who has charge of hiring and training young graduate engineers, discussed the training program which his company has in effect. He said that the Ford Motor Company is interested in young men with vision, character, mental alertness, a good knowledge of subject areas, and in those who want to do a "bang-up job." The speaker graciously answered questions at the

MEMBERS OF STUDENT BRANCH OF NEW YORK UNIVERSITY DURING INSPECTION TRIP

STUDENT BRANCH OF UNIVERSITY OF MISSOURI

(*Front row, left to right* James D. Locke, Herbert W. Hazen, Robert W. Baebler, Joe E. Meals, Leonard Wm. Lutz, A. E. Buescher, J. H. Hatch; *Second row, left to right* Charles A. Buehler, K. J. Forguharson, A. Hubbard, J. V. Garnett, P. K. Landtiser, John W. McKiernan, Charles Horste; *Third row, left to right* A. Pitney, J. Sturdenant, James McCubbin, G. Hesemann, Stanley Riley, Prof. M. M. Bolstad, Ed. Sweeney; *Fourth row, left to right* Nicklos Kershaw, Wm. Bushnell, E. E. Ditterline, Eugene Wilson, Prof. E. Smith, Prof. R. E. Scorah, and Prof. E. C. Phillips.)

close of the talk. Committees were appointed during the business meeting, as follows: Poster, Larry Talbot; announcements, Bill Carlson, Ed Mazurkiewicz, and Kneeland Welch; refreshments, Frances Jenkins and Sally Farquhar; party, David VanTuyl and Larry Talbot.

At the meeting on March 13 a letter from Ralph Cunningham was read which discussed the events to take place at the Notre Dame convention and in which he asked that delegates from the University of Michigan be appointed. It was announced that Louis M. Benkert of the Progressive Welding Company of Detroit, Mich., would be the guest speaker at the next meeting. Plans for a forthcoming party were made, and suggestions were asked for the programs of future meetings. A new program committee was appointed as follows: Frank Amon, Bill Smith, and John Howell. The program for the evening was a talk by Prof. Richard Schneidewind on "Permanent Mold Iron." The talk was illustrated with slides from research work the speaker had done on the subject.

Mississippi State College Branch

The first postwar meeting was held on March 12 in 110 Engineering Building, for the purpose of reorganization and planning an active program. Prof. H. P. Neal, junior member A.S.M.E., opened the meeting with a short history of the A.S.M.E. and of the local branch, and closed his talk with a summary of the benefits of this organization. Officers were elected as follows: Prof. H. P. Neal, honorary chairman; F. O. Bragg, chairman; M. W. Bentley, vice-chairman; H. E. Wardlaw, Jr., secretary; R. S. Musselwhite, treasurer; Prof. A. G. Holmes, member A.S.M.E. The present branch members are: M. W. Bentley, F. O. Bragg, J. Cordero, C. J. Germany, F. S. Manning, Jr., C. D. Moore, R. S. Musselwhite, A. D. Pope, G. J. Saab, J. O. Stephens, F. T. Wadley, and H. E. Wardlaw, Jr.

Missouri University Branch

At the March 28 meeting in the University Engineering Building a demonstration of a "metallizing gun" was shown. An explanation of the gun and its uses was given by the demonstrator, Mr. Perkins. The chairman announced the committees which were selected for work to be done at the meeting in St. Louis, Mo., on April 12 and 13. A movie entitled "Construction of the Golden Gate Bridge" was shown.

New York University Branch

At the Feb. 27 meeting sponsored by the evening division, in the Education Auditorium, Washington Square, New York, N. Y., Otto de Lorenzi, member A.S.M.E., director of education, Combustion Engineering Company, New York, N. Y., spoke to the day and evening divisions of the branch on "A Study of Stoker Fuel Beds." Mr. de Lorenzi presented data obtained from "speed-up" pictures taken of stokers and illustrated with films. He pointed out that a careful study of the results by both fuel supplier and stoker engineer would lead to a better understanding and solution of mutual problems.

A meeting was held with the Institute of Aeronautical Sciences on March 1 at Lawrence House. Prof. Frederick K. Teichmann, member A.S.M.E., chairman of the aeronautical-engineering department, discussed his trip to occupied Germany during the summer of 1945 and told of many interesting things in connection with his work there. Professor Teichmann was one of the members in a group of American scientists and engineers whose duty it was to catalogue, translate, and evaluate German aeronautical research. According

STUDENT BRANCH OF PURDUE UNIVERSITY

to the records, the wildest schemes were sanctioned and supported with plenty of money, materials, and manpower, and as is now well known some of the German work was successful and highly dangerous. Following Professor Teichmann's talk, a film entitled "Keep 'em Flying" was shown. This dealt with hydraulic controls for blade angles in the propeller hub.

On March 21 in Lawrence House, Prof. Herman J. Brenneke, junior member A.S.M.E., of the mechanical-engineering department, spoke on "Applications of Welding to Metals Fabrication." Professor Brenneke, who has just returned from a wartime leave of absence in Detroit, emphasized the pressing need for more unbiased literature and information on welding processes. He said that no single welding process is a cure-all for every production problem, although some manufacturers will try their best to convince the engineer. He pointed out that arc welding could not be applied to a specimen of thin cross section and that the old gas-welding process was still more suitable for this purpose. A question period followed the talk.

University of Nebraska Branch

The branch was host to the Nebraska Section on March 20. Honorary chairman Niles H. Barnard introduced the guest speaker, Glenn C. Boyer of Burns and McDonnell, Kansas City, Mo., who spoke on "Engineering as a Profession." A reprint from the magazine *Power*, "So You Want To Be an Engineer," was distributed to the members. After his talk Mr. Boyer led a discussion period, followed by the introduction of officers of the branch and Section.

Purdue University Branch

The program at the March meeting was a speech contest. Howard Eklind made the winning speech on the subject "The Development of the Gas Engine." Mr. Eklind gave the complete history of gas engines from Huygens to Otto, showing the evolution of the two-cycle and four-cycle engine. A discussion period followed. Mr. Eklind will act as delegate from the branch at the regional meeting to be held at Notre Dame University on April 29 and 30.

Queen's University Branch

On March 15 the members made a trip through the Kingston plant of the Aluminum Company of Canada. Of special interest on the tour were the large rolling mills, the extrusion presses, and the many ingenious ways of handling aluminum in its various stages of development. This visit was one of the most interesting made by the branch in recent years.

Rensselaer Polytechnic Institute Branch

On March 11 the opening meeting for the current semester was held and proved to be exceedingly interesting. A brief talk was given reminding students to file application for membership and renew those which will soon expire. A showing of three films followed. The first, entitled "Arc Welding," was a story of the development of modern arc welding and the important part which it played in speeding the war effort. The second was an explanation of the gyrocompass, and the third film gave an excellent approach to a recent development in navigational instruments and was concerned with one called the gyronometer, which embodies the good points of both the magnetic compass and the gyrocompass. It requires no correction for gyroscopic drift, and its reading is at all times correct within 1 per cent.

Rice Institute Branch

The first meeting of the present semester was held on March 22 in Chemistry Lecture Hall, for the purpose of interesting students in the benefits of A.S.M.E. membership and to discuss plans for the term. Trips to various plants were suggested and possible lectures and films were discussed. Leo Raver, president, expressed the hope that at least one paper would be presented by a member of the branch at the Group Convention. It was suggested that a committee be appointed to represent the branch, even though no paper is sent.

University of Rochester Branch

The first regular meeting of the current term was held on March 12 in the Rush Rhees Library. Introduction of new officers and committeemen was followed by a short business meeting. Nelson Sheldon of the Carrier Corporation, was the speaker. His topic was "Modern Industrial Air-Conditioning." R. E. Cherne, consulting engineer, formerly with the Carrier Corporation, led an open discussion on air-conditioning.

At the March 26 meeting, held in the Rush Rhees Library, two new amendments were added to the by-laws; one, to provide for "limited" membership in the branch, a limited member to be permitted to participate in all activities except those specifically restricted to student members of the A.S.M.E.; the other amendment, providing that officers should hold office for a full year. The program consisted of a showing of a film.

Rose Polytechnic Institute Branch

Election of officers was held at the March 13 meeting, with the following results: Lyndon E. Eberly, Jr., chairman; Robert T. Penno, vice-chairman; William H. Jarrett, Jr., treasurer. Chairman Harold E. Campbell gave a short talk on the coming student conference. Mr. Sutton volunteered to prepare a speech for presentation at Notre Dame.

University of Santa Clara Branch

At the Feb. 28 meeting new members were introduced and forms for membership distributed. The guest speaker was Alfred Wolff, a graduate of the University, who gave a talk on "Industrial Engineering, Its Different Aspects and Its Interest to the Prospective Engineer." A general discussion followed.

On March 13 a program committee was appointed. After the business meeting a film was shown entitled "Fabrication of Plastics."

South Dakota State College Branch

At the March 6 meeting in the Engineering Building, the following committees were appointed: Meetings and Papers, Eugene H. Case and John O. Kuinge; Membership, Glen S. Cherney. One new member was welcomed, James Trenerry.

University of Tennessee

On Fed. 14 in Estabrook Hall a short business meeting was held, following which Prof. F. H. Thomas spoke of the Spring Meeting to be held in Chattanooga, Tenn., in April. Program chairman, James Slagle introduced the speaker, Carlos Campbell, well-known Knoxville photographer and authority on the Great Smoky Mountains. Mr. Campbell gave an interesting talk on points of interest in the Smokies and showed many fine pictures of those mountains.

Tufts College Branch

At the business meeting on Feb. 18 in Robinson Hall, election of officers was held, with the following results: Leray Freoberg, president; Edgar MacCormack, vice-president; Maxwell Ferrotta, secretary-treasurer, and Prof. David Fisher, junior A.S.M.E., assistant professor of mechanical engineering, Engineering School, Tufts College, as honorary chairman. New engineers in the school were signed up at this meeting and all the graduating seniors made out their transfers to junior membership. It

EXECUTIVE COMMITTEE OF THE STUDENT BRANCH OF UNIVERSITY OF TORONTO, 1945–1946

(*Front row, left to right:* J. E. McEwen, papers and meetings secretary; R. W. Stedman, vice-chairman; Prof. I. W. Smith, honorary chairman; E. J. Durand, chairman; N. L. Brown, secretary-treasurer; *Back row, left to right:* D. R. Yeomans, three-year representative; H. Dederer, two-year Representative; A. E. Dalrymple, four-year representative.)

was voted to send a gift of appreciation to Richard Wentling, president of the branch, who is in the Chelsea Naval Hospital undergoing an eye operation.

University of Washington Branch

On March 27 in the Guggenheim auditorium an invitational meeting was held, to hear Larry Johnson speak on "The Future of Engineering in the Northwest and How It Will Affect You."

Mr. Johnson is a graduate with degrees in mechanical and electrical engineering and is working for the U. S. Employment Service.

Otis Lamson, vice-chairman, A.S.M.E. Western Washington Section, told prospective members of the advantages of A.S.M.E. membership.

Worcester Polytechnic Institute Branch

A brief emergency meeting was held on March 16 in Higgins Laboratories for the purpose of selecting a new secretary-treasurer. Allen Breed, who resigned, was succeeded by Gerald F. Hickey, a former student member who recently returned from the Navy.

A.S.M.E. Sections

Coming Meetings

Anthracite-Lehigh Valley. May 24. Hotel Altemont, Hazleton, Pa. at 8:00 p.m. Subject: "Selection of Steels for Fabrication," by W. G. Theisinger, assistant to vice-president, Lukens Steel Company.

Chicago. May 18. Annual Meeting of Section. Time and Place of meeting to be announced.

New Haven. May 25. The Thirteenth Annual Meeting of the Connecticut A.S.M.E. Sections, at Lawn Club, New Haven, Conn. Speakers: Harry R. Westcott, consulting engineer will be the toastmaster; Alton C. Chick, vice-president A.S.M.E. Region I; William M. Sheehan, chairman of A.S.M.E. Membership Development Committee; and C. E. Davies, secretary, A.S.M.E. Two motion pictures will be shown: "Modern Living" by Westinghouse Electric Corporation and "Jet Propulsion" by Bell Aircraft Corporation.

Philadelphia. May 28. Annual Outing. Details to be announced.

Virginia. May 24–25. Norfolk, Va. Meeting of the Engineering Societies of Virginia. D. Robert Yarnall, president, A.S.M.E., will address the luncheon meeting on Friday, May 24.

Metropolitan. May 8. Morning and afternoon session, Management Division, Room 501[1]. Subject: "Increasing Production to Better Industrial Relations." Luncheon at Hotel Pennsylvania, New York, N. Y.

May 24. Joint Meeting A.S.M.E. Metropolitan Section and American Rocket Society. General Discussion of Rocket Development.

[1] Engineering Societies Building, 29 West 39th St., New York, N. Y.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative, nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. All replies should be addressed to the key numbers indicated and mailed to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3 per quarter or $10 per annum, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	212 West Wacker Drive	109 Farnsworth Ave.	57 Post Street

MEN AVAILABLE[1]

GRADUATE ENGINEER, mechanical, 38, married. Thirteen years' experience plant engineer, plant superintendent, automatic screw machines, turret lathes, machine shop, tool and die making, press-room plant construction and maintenance. Me-36.

GRADUATE MECHANICAL ENGINEER, Nova Scotia Technical College, 1946, 21, American citizen, single. Industrial mechanical experience during summers. Best references. Desires permanent position with opportunities. Locality immaterial. Available May 1. Me-37.

GRADUATE MECHANICAL ENGINEER, 26, former Naval officer, single. Two years engineering sales in industrial instruments, three years production Navy fire-control equipment. Desires position in engineering sales or management. Me-38.

INDUSTRIAL ENGINEER, 32, married, graduate. Experienced installation, administration of wage incentives, job evaluation, cost systems. Consulting engineering and seven years' industrial experience including plant management in Mexico. Excellent writer. Now Commander, U.S.N.R. Me-39.

MECHANICAL ENGINEER, 28, best-qualified in quality control, inspection supervision. Experienced systems installation, cost analysis, production metal products; 2½ years officer responsible for quality control Navy rocket-gun ammunition. Prefer industrial management firm. Me-40.

MECHANICAL ENGINEER, 26, recent graduate, married, desires permanent position with future in design and production engineering. Power plant, heat-transfer equipment, or air conditioning preferred. Available immediately. East. Me-41.

MECHANICAL ENGINEERING, graduate engineer, mechanical, 28, family. Experienced technical writer and public-relations man. Desires foreign location. Can handle advertising, promotion, contact, or sales. Will also consider some sections this country. Me-42.

MECHANICAL ENGINEER, 28, B.S. honors; 5 years' experience layout and design Naval power-plant machinery and mechanical systems including investigations and test. One year shop and design experience in steam turbines. Me-43.

MECHANICAL ENGINEER, graduate studies, one year design, two years' test and development variety plant equipment for heavy-machinery manufacturer. Desires position assistant plant engineer with progressive firm, New York, N. Y., area. Me-44.

MECHANICAL ENGINEER, graduate, 33, ex-naval officer, ten years' manufacturing experience. Knows requirements and problems of either large or small quantity production. Desires position leading to factory manager. Available immediately. Me-45.

EX-ARMY OFFICER. Experienced in aircraft tooling and maintenance and construction-equipment maintenance. B.S. in mechanical engineering. Eager and energetic. Will travel. Salary unimportant if opportunities are good. Me-46.

INDUSTRIAL ENGINEERING GRADUATE, single, Tau Beta Pi, 31. Four years' production, installation salary administration, labor relations staff, steel mill. Two years' administrative Naval officer. Desire position industrial engineering or assistant to management. Me-34.

MECHANICAL ENGINEER, 26, married, ex-Naval officer. Experienced machinist and machine designer. Cooper Union graduate, master's degree pending. Desires executive position as production, development and testing, or installation engineer on machinery. Me-35.

MECHANICAL - METALLURGICAL - PRODUCTION ENGINEER, 33, married, Stevens graduate. Six and one-half years' broad steel and carbide application to cold- and hot-metal fabrication; 3 years' responsible ordnance production and administration. Desire engineering, production, or sales position with future. Me-31.

[1] All men listed hold some form of A.S.M.E. membership.

INDUSTRIAL ENGINEER, 27, for factory organization, procedures, cost surveys, product development. Six years' experience in aircraft-manufacturing production planning, materials handling, floor layout, operation analysis, methods, procedures. Me-32.

GRADUATE MECHANICAL ENGINEER, BME, 23, single. Research or applied mechanics with opportunity to advance and augment knowledge pursuing graduate studies and training at work. Fifteen months' experience in plastics industry. Me-33.

PRODUCTION ENGINEER, graduate M.E., 36, Sixteen years' extensive industrial experience in manufacturing methods, tooling, planning, time study, wage incentives. Eight years in supervisory and administrative positions. Me-47.

POSITIONS AVAILABLE

INDUSTRIAL ENGINEER to head up industrial-engineering department for plywood mill. Must be capable of plant incentive installations, production controls, plant layout and methods, conducting effective training programs for plant supervision and labor. $7500–$10,000, South. W-6944.

WORKS MANAGER, 40–45, mechanical graduate with at least 5 years' experience as assistant manager or production manager of light-steel-products plant, to realign production management and supervise operation of several plants in East. $15,000–$20,000. Headquarters, New York, N. Y. W-6955.

ENGINEERS. (*a*) Plant engineer, 40–45, with at least 10 years' experience in pulp and paper mills, to take charge of power and maintenance. $5000–$6000. (*b*) assistant plant engineer, 25–35, with several years' electrical-maintenance experience, preferably paper mill, to be responsible for design, installation, and maintenance of all electrical equipment under supervision of plant engineer. $3000–$4000. Pennsylvania. W-6957.

EXECUTIVE ENGINEERS, 35–45, mechanical or electrical graduates of recognized colleges with at least 5 years' experience in industry in executive capacity. Will be responsible for efficient, businesslike operations of medium-sized engineering department, completely staffed technically. $7500–$8000, plus profit sharing. One for truck assembly plant south central New York; one for communications-equipment plant, Connecticut. W-6958.

FACTORY MANAGER, 35–45, preferably engineering graduate, 5 to 10 years' successful experience in plant managerial positions, to take charge of manufacturing wood products and low-pressure-molded laminates. $6000–$7000. New Jersey. W-6961.

MECHANICAL ENGINEER, 30–40, graduate, with mechanical design and shop experience in knitting or automatic machinery, to carry out additional development and instigate its manufacture and completion. Plant engineering experience would be helpful. $4800. Pennsylvania. W-6962.

ASSISTANT PROFESSORS. (*a*) Assistant professor of mechanical engineering, B.S. or engineering degree, with three to four years' experience in machine-design field, to teach machine design and kinematics, $3500–$3900. (*b*) instructors, recent graduates, with B.S. or engineering degrees, to teach engineering drawing and descriptive geometry. $2300. Opportunity for graduate work at other institutes start September 1, 1946. New York, N. Y. W-6963.

ASSISTANT PLANT ENGINEERS, 25–30, with 4 to 5 years' experience in maintenance of pumps, filters, and grinders, to do general plant engineering in chemical works. $3600–$4200. New York, N. Y. W-6964.

MECHANICAL ENGINEER, preferably with some experience in maintenance of Diesel-power units, screens, and conveyers. Any light construction experience desirable. $4500 plus subsistence. Haiti. W-6966.

ENGINEERS, civil, electrical, mechanical, and architectural; work involves designs and specifications for widely diversified structures and facilities to be constructed in new reclamation program. Openings also in hydrology division, project-planning branch, and power-utilization branch. Government positions. $2320–$6230, plus overtime. Headquarters, Colorado. W-6967.

INDUSTRIAL RELATIONS ASSISTANT, 25–30, college graduate majoring in industrial-relations or personnel administration, with thorough knowledge of merit rating, job evaluation, job analysis, and job descriptions. $3000. Northern New Jersey. W-6968.

INSTRUCTORS, two for mechanical-engineering department; one to teach laboratory courses in testing of engines and other mechanical equipment, also strength of materials laboratory. Will be required to assist in maintenance of laboratory equipment. Other to teach courses in production management and motion and time study. Will be required to develop and teach courses. $2400, school year. Ohio. W-6969 D.

ENGINEERS, young, mechanical or electrical graduates or equivalent in experience, interested in making a connection with old-established machine-tool-building company embarking on expansion program. Ohio. W-6970 D.

ASSISTANT POWER-PLANT SUPERINTENDENT, under 40, with two or more years' experience in industrial power plant, to assist in supervision and maintenance of turbogenerators, 250 lb steam boilers and other equipment. Must know Spanish. $4800. Cuba. W-6973.

ADMINISTRATIVE ENGINEERS, mechanical graduates, young, experienced in field of powder metallurgy as especially applied to friction material for automotive, tractor, industrial, and other applications. $6000–$10,000. Ohio. W-6974 D.

ENGINEERS. (*a*) technical writer, engineering graduate, with proved ability to write, to prepare technical descriptive matter for instruction-book purposes on steam and gas turbines, centrifugal pumps and compressors, and helical gears; (*b*) design engineer, graduate, with shop or drafting-room experience in gear design, to carry on research in development of new type gear units, supervise running of experimental tests, examine and extract patents, and furnish engineering information in answer to customer inquiries. Northern New Jersey. W-6975.

DESIGN ENGINEER, mechanical graduate desired, preferably with experience in metal-working such as sheet-metal drawing and stamping, casting, and machine operations, to design small mechanical parts in such manner as to make most of material and manufacturing processes. $3500–$4000. Massachusetts. W-6976.

GRADUATE MECHANICAL ENGINEER, 30 to 40. Creative ability and good theoretical background being first consideration. Should have experience in plant layout, preferably material-handling plants. Would have to spend part time in field to become acquainted with work and machinery but main duties will be design and estimating of coal-handling and cleaning plant, in Chicago loop office. $4000 to $5000. R-3346-C.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after May 25, 1946, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Fellow, Member, Associate or Junior

ARBURU, J. M., Key West, Florida (Rt & T)
AUSTIN, W. E., JR., Roanoke, Va.
BAHLMAN, HENRY L., Mishawaka, Ind.
BAKSA, STEPHEN, New Brunswick, N. J.
BARNABY, JAMES C., Short Hills, N. J.
BARNES, LEROY E., Evanston, Ill.
BARRON, HENRY B., Elizabeth, N. J.
BASON, C. B., Los Angeles, Calif.
BELL, DAVITT S., Pittsburgh, Pa.
BENNETT, RICHARD A., Philadelphia, Pa. (Re)
BENTELE, WILLIAM H., New York, N. Y.
BIENSTOCK, G. J., New York, N. Y. (Rt & T)
BLUM, ROGER G., Scarsdale, N. Y.
BOLLINGER, EARL C., Oak Ridge, Tenn.
BOWEN, J. A. (LIEUT. COMDR.), Fresno, Calif.
BOWLES, J. D., Kansas City, Mo. (Rt)
BRADDON, GEORGE D., Wellsville, N. Y. (Rt & T)
BROWN, WILLIAM H., San Francisco, Calif.
BROWNELL, F. B., Jeannette, Pa.
BURKROSS, JAMES E., Glenview, Ill.
BUTT, WAYNE C., Lockport, N. Y.
CANDLIN, J. E., JR., Chicago, Ill.
CATLAND, RAYMOND O., Glendale, Calif. (Rt & T)